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200 Kent Street
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Conseil de recherches en sciences
naturelles et en génie du Canada

200, rue Kent
Ottawa, Canada
K1A 1H5

STRATEGIC GRANTS IN INDUSTRIAL MATERIALS AND PROCESSES

LES SUBVENTIONS THÉMATIQUES EN MATÉRIAUX ET PROCÉDÉS INDUSTRIELS

- **Summaries of New Research Projects**
  Résumés des nouveaux projets de recherche

- **List of On-going Research Projects**
  Liste des projets de recherche en cours

- **Summaries of Completed Research Projects**
  Travaux de recherche terminés

1986-87

Canada

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FOREWORD / AVANT-PROPOS

FOREWORD

The Natural Sciences and Engineering Research Council offers a program of strategic grants to initiate or accelerate research projects in areas of Canadian interest. The aim of the program is to enable university researchers to make greater contributions than in the past towards the understanding or solution of problems of national concern, either through specific applied research projects having potential for relatively short-term benefits, or through more basic research activities designed to develop knowledge in areas of potential importance. The total budget for the strategic grants program for 1986-87 is $32 million.

In 1986-87 the strategic grants program addressed eight specific fields: 1) biotechnology, 2) communications and computers, 3) energy, 4) environmental toxicology, 5) food and agriculture, 6) industrial materials and processes, 7) oceans, and 8) open (which includes areas of national concern other than the seven identified fields).

Selection panels composed of recognized scientists and engineers from the university, industry and government sectors rate all proposals using the following criteria:

- scientific merit of the proposed research;
- excellence of the applicant(s);
- relevance of the proposed research to the field.

AVANT-PROPOS

Le Conseil de recherches en sciences naturelles et en génie offre un programme de subventions thématiques visant à lancer ou à accélérer des projets de recherche dans des domaines d'intérêt national. Le but de ces subventions est de permettre aux chercheurs universitaires de contribuer davantage à la compréhension et à la solution de problèmes d'intérêt national. Il peut s'agir de recherche appliquée pouvant s'avérer utile à court terme ou encore de recherche plus fondamentale destinée à augmenter la somme des connaissances dans des domaines d'intérêt national. Le budget total du programme en 1986-1987 est de 32 millions de dollars.

En 1986-1987, le programme de subventions thématiques comprenait huit domaines choisis:
1) l'alimentation et l'agriculture, 2) la biotechnologie, 3) l'énergie, 4) les matériaux et procédés industriels, 5) les océans, 6) le thème "ouvert" (regroupant des domaines d'intérêt national autres que les sept domaines choisis), 7) les télécommunications et l'informatique et enfin, 8) la toxicologie de l'environnement.

Des comités de sélection composés de scientifiques et d'ingénieurs reconnus provenant des secteurs universitaire, industriel et gouvernemental utilisent les critères suivants pour évaluer toutes les demandes:

- valeur scientifique de la recherche proposée;
- excellence des candidats;
- pertinence du projet par rapport au domaine désigné.

Each criterion carries equal weight. To be funded, an application must receive a high ranking under each of the three criteria. Regional considerations do not enter into the evaluation of proposals submitted under this program. The panels are responsible for deciding what is relevant to, and of priority within, the broad areas identified for support, consistent with the descriptions of the fields.

Les comités doivent accorder une importance égale à chacun des critères. Pour obtenir une subvention, le projet doit recevoir une cote élevée en fonction de chacun des trois critères. Les considérations régionales ne doivent pas entrer en ligne de compte dans l'examen des demandes. Les comités ont la responsabilité de déterminer la pertinence des divers secteurs et leur priorité à l'intérieur de chaque domaine désigné, en se basant sur les descriptions des domaines.

The strategic grants program contributes to the training of research manpower and encourages the transfer of technology to the user sector. This is the basis of its success. To facilitate this technology transfer, NSERC annually publishes booklets describing some of the research funded through the program. There is a separate booklet for each field; each one contains summaries of the new research projects funded as a result of the annual strategic grants competition, a list of all on-going projects funded by NSERC in the particular field, and summaries of strategic research projects completed in 1986, including references to publications arising from the NSERC-funded research. Further information on the research being supported by NSERC may be obtained by contacting the researcher directly, or the Strategic Grants Division at (613) 996-1597.

Le programme de subventions thématiques contribue à former des chercheurs et donne lieu à un transfert de technologie au secteur des utilisateurs: voilà la base de son succès. Afin de faciliter le transfert de technologie, le CRSNG publie, chaque année, des livrets décrivant la recherche subventionnée dans le cadre de ce programme. Chaque domaine fait l'objet d'un livret séparé; on y retrouve un résumé des nouveaux projets de recherche subventionnés suite au concours annuel de subventions thématiques, une liste de tous les projets en cours dans le domaine en question subventionnés par le CRSNG et un résumé des projets de recherche thématique terminés en 1986, y compris des références aux publications découlant de la recherche subventionnée par le CRSNG. Des renseignements supplémentaires sur les projets de recherche appuyés par le Conseil peuvent être obtenus en communiquant avec le chercheur lui-même ou avec la division des subventions thématiques au (613) 996-1597.

NSERC offers other opportunities for technology transfer under its university/industry program. Further information on this program or on any of NSERC's awards programs may be obtained by calling (613) 995-5992 or by writing:

NSERC
Communications Division
200 Kent Street
Ottawa, Ontario
K1A 1H5

Le CRSNG offre d'autres possibilités pour le transfert technologique grâce à son programme conjoint universités-industrie. Pour plus d'information sur ce programme ou sur les autres programmes du CRSNG, veuillez téléphoner au (613) 995-5992 ou vous adresser au:

CRSNG
Division des communications
200, rue Kent
Ottawa (Ontario)
K1A 1H5

FIELD DESCRIPTION / DESCRIPTION DU DOMAINE

Natural Sciences and Engineering Research Council of Canada

Conseil de recherches en sciences naturelles et en génie du Canada

INDUSTRIAL MATERIALS AND PROCESSES

Strategic Grants in Industrial Materials and Processes are intended to encourage research in innovative processes, materials and technology and the means for achieving their application to efficient industrial-scale production.

The following list includes areas in which proposals will be considered. The list is by no means exhaustive.

Materials

Materials encompasses the development of new substances of industrial importance, the characterization of their properties and the investigation of their behavior in industrial applications. Innovative uses of existing materials are also included.

Examples of materials are:

- Cellulosics
- Polymers
- Ceramics
- Composites
- Metals and Alloys
- Coatings
- Construction Materials
- Semiconductors

Manufacturing Processes

The exploitation of natural resources to produce raw materials, or the transformation of raw materials to intermediates or finished products generally involves a sequence of processing steps, which result in a more valuable product. Examples of such processes are:

- Chemical and catalytic processes: conversion of hydrocarbon- and coal-based feedstocks, hydrogenation (C_1 chemistry) processes, processing for foreign-atom removal (S and N), polymerization processes, etc.
- Raw material extraction: beneficiation including grinding, agglomeration, etc.
- Metallurgy: refining, casting, joining, alloy and property development, coating, corrosion protection, etc.
- Production of ceramics: glasses, refractories, cements, etc.
- Production of industrial gases
- By-product and/or waste utilization
- Forest product (pulp and paper) processes
- Manufacture of semiconductor materials
- Fabrication of new construction materials

MATÉRIAUX ET PROCÉDÉS INDUSTRIELS

Les subventions thématiques dans le domaine des matériaux et procédés industriels visent à encourager la recherche dans les procédés, les matériaux et les technologies innovatrices et à assurer les moyens de parvenir à appliquer les résultats de cette recherche à une production efficace à l'échelle industrielle.

Voici une liste, qui n'est nullement exhaustive, des domaines dans lesquels on attend des propositions.

Matériaux

Ce domaine comprend le développement de nouvelles substances d'importance industrielle, la caractérisation de leurs propriétés et l'étude de leur comportement dans des applications industrielles, ainsi que la mise au point d'utilisations innovatrices de matériaux déjà existants.

Voici des exemples de matériaux:

- Produits cellulosiques
- Polymères
- Céramiques
- Composites
- Métaux et alliages
- Revêtements
- Matériaux de construction
- Semi-conducteurs

Procédés

L'exploitation des ressources naturelles pour la production des matières premières, ou la transformation de matières brutes en produits intermédiaires ou finis fait intervenir en général une suite d'étapes de traitement dont le résultat est un produit amélioré. Voici des exemples de ces procédés.

- Procédés chimiques et catalytiques: conversion des charges de départ à base d'hydrocarbures et de charbon, procédés d'hydrogénation (chimie du C_1), traitement pour éliminer les hétéroatomes (S et N), procédés de polymérisation, etc.
- Extraction des matières brutes: enrichissement des minerais par broyage, agglomération, etc.
- Métallurgie: raffinage, coulage, assemblage, développement d'alliages et amélioration de leurs propriétés, revêtements, protection anticorrosion, etc.
- Production de céramiques: verres, produits réfractaires, ciments, etc.
- Production de gaz industriels
- Utilisation des sous-produits et/ou des déchets
- Recherche sur les procédés de transformation des produits forestiers (pâtes et papiers)
- Fabrication de matériaux semi-conducteurs
- Fabrication de nouveaux matériaux de construction

Integrated Systems

Efficient production and assembly requires the union of machines, processes, material handling, information systems, and design into an integrated manufacturing system. Topics suitable for study include:

Manufacturing systems

- Flexible manufacturing
- Computer integrated manufacturing
- Robotics as applied to manufacturing and assembly
- Automated material handling and storage
- Computer-aided testing
- Process controls and sensors

Management Systems

- Production control, simulation and optimization
- Quality assurance and control systems
- Construction planning
- Production planning
- Integrated system design, operation and control
- Computer-aided management support systems
- Integration of design and manufacturing (CAD/CAM)

February 1986

Systèmes intégrés

Pour que la production et l'assemblage soient efficaces, il faut réunir les machines, les procédés, la manutention des matériaux et les systèmes d'information dans un système intégré de fabrication. Voici des exemples de sujets d'étude.

Les systèmes de fabrication

- Fabrication souple
- Fabrication intégrée par ordinateur
- Utilisation de robots pour la fabrication et l'assemblage
- Automatisation de la manutention et du stockage des matériaux
- Essais assistés par ordinateur
- Contrôles et détecteurs pour les procédés

Systèmes de gestion

- Contrôle, simulation et optimisation de la production
- Systèmes d'assurance et de contrôle de la qualité
- Planification de la construction
- Planification de la production
- Conception, exploitation et contrôle des systèmes intégrés
- Système de soutien de la gestion assistée par ordinateur
- Intégration de la conception et de la fabrication (CAO/FAO)

février 1986

LIST OF NEW PROJECTS / LISTE DES NOUVEAUX PROJETS

Industrial Materials and Processes / Matériaux et procédés industriels

Name/Nom Department/Département University/Université	Title/titre	$*	Page
1. Polymers and Composites / Polymères et composites			
Carreau,P.J. Génie chimique École Polytechnique	Extrusion des matériaux plastiques * avec P.G. Lafleur, M. Grmela, T.M. Malik, B. Fisa (École Poly.)	267,220	21
Dealy,J.M. Chemical Eng. McGill	The use of rheological sensors for process control in the plastics industry * with W.I. Patterson (McGill)	150,700	25
Guillet,J.E. Chemistry Toronto	Polymers for electronic applications * with M.A. Winnik, W.F. Reynolds, S.G. Whittington (Toronto)	415,500	33
Winnik,M.A. Chemistry Toronto	Design of better polymeric materials for use as flocculants and pusher fluids * with J.E. Guillet, S.G. Whittington, W.F. Reynolds, D.F. James (Toronto)	349,500	46
2. Semiconductors / Semi-conducteurs			
Card,H.C. Electrical Eng. Manitoba	Microwave plasma deposition and etching for VLSI * with K.C. Kao, D.T. Thomson, R.D. McLeod (Manitoba)	158,000	20
Datars,W.R. Physics McMaster	Physical properties of strained-layer heterostructures * with T. Timusk, A.A. Berezin (McMaster)	178,443	24
Thompson,D.A. Eng. Physics McMaster	Strained layers and strained layer superlattice structures for device applications * with B.K. Garside, P.E. Jessop, J.A. Davies (McMaster)	213,250	43
3. Ceramics and Cements / Céramiques et ciments			
Bale,C.W. Metallurgical Eng. Ecole Polytechnique	Calcium B-alumina and calcium zirconium orthophosphate ionic ceramics for use as chemical sensors in steelmaking * with A.D. Pelton (Ecole Poly.), D.A.R. Kay (McMaster) (also listed in metals & metallurgy)	212,000	18

* Total funds committed/Montant total accordé

Name/Nom Department/Département University/Université	Title/titre	$*	Page
3. Ceramics and Cements / Céramiques et ciments			
Chaklader,A.C.D. Metallurgical Eng. British Columbia	Plasma synthesis of sinterable SiC and Si3N4 powders * with R.G. Butters (UBC)	159,000	22
Drew,R.A.L. Mining/Metal. Eng. McGill	Development of sialon ceramics for high temperature applications	226,000	27
Nicholson,P.S. Materials Science McMaster	Synthesis of textured AlN polycrystals for high frequency ultrasonic transducers	187,434	39
4. Metals and Metallurgical Process / Métaux et procédés métallurgiques			
Bale,C.W. Metallurgical Eng. Ecole Polytechnique	Calcium B-alumina and calcium zirconium orthophosphate ionic ceramics for use as chemical sensors in steelmaking * with A.D. Pelton (Ecole Poly), D.A.R. Kay (McMaster) (also listed in ceramics)	212,000	18
Finch,J.A. Mining/Metal. Eng. McGill	Mineral processing of fines * with N. Rowlands, A.R. Laplante (McGill)	160,000	29
McLean,A. Metal/Mat. Science Toronto	Tundish metallurgy * with I.D. Sommerville, S. Argyropoulos (Toronto)	449,000	37
Samarasekera,I.V. Metallurgical Eng. British Columbia	Microstructural evolution during hot rolling of steel * with E.B. Hawbolt, W.S. Dunbar (UBC)	232,300	40
Sommerville,I.D. Metal/Mat. Science Toronto	Optimization of weld metal properties through control of flux chemistry * with T.H. North (Welding Inst. of Can.)	166,500	42

* Total funds committed/Montant total accordé

Name/Nom Department/Département University/Université	Title/titre	$*	Page
5. Tribology / Tribologie			
Embury,J.D. Materials Science McMaster	Friction and wear in non-metallic materials	96,474	28
Yellowley,I. Mechanical Eng. McMaster	Basic investigation of metal cutting mechanics and tool wear * with R. Sowerby, D.A.R. Kay (McMaster)	62,978	47
6. Catalysts and Catalytic Processes / Catalyseurs et procédés catalytiques			
Kaliaguine,S.C.F. Génie chimique Laval	Développement de catalyseurs bi- et trifonctionnels à base d'oxydes de métaux de la famille du fer supportés sur une zéolithe	148,500	34
Lessard,J. Chimie Sherbrooke	Recherche de "chémosélectivité" dans l'électrohydrogénation catalytique de molécules organiques à l'aide de nouveaux matériaux d'électrodes * avec G. Belot, A. Lasia (Sherbrooke)	182,744	35
Lipkowski,J. Chemistry & Biochem. Guelph	Glassy metals as new electro-catalysts for fuel cells	123,660	36
Moffat,J.B. Chemistry Waterloo	Selective conversion of methane on designed heteropoly oxometalates	144,000	38
7. Pulp and Paper Processes / Procédés de transformation des pâtes et papiers			
Avedesian,M.M. Chemical Eng. McGill	Fluidized bed recovery of kraft black liquor - A new alternative * with A.S. Mujumdar (McGill)	55,500	17
Foschi,R.O. Civil Engineering British Columbia	Structural reliability of systems with wood-based materials * with J.D. Barrett (UBC)	679,000	32

* Total funds committed/Montant total accordé

Name/Nom Department/Département University/Université	Title/titre	$*	Page
8. Novel processes / Nouveaux procédés			
Chavarie,C. Génie chimique École Polytechnique	Mise en oeuvre des catalyseurs d'aérogels en courches fluidisées et en lits circulants, développement d'un nouveau procédé d'hydrogénation et étude de la production de ces solides par lyophilisation * avec D. Klvana (École Poly.), J.R. Grace (UBC)	222,100	23
DeLasa,H.I. Chemical Eng. Western Ontario	Three phase fluidization at high temperature and pressure	40,000	26
Wan,J.K.S. Chemistry Queen's	Chemical applications of microwave technology in industrial processes	181,500	45
9. Lasers / Lasers			
Seguin,H.J.J. Electrical Eng. Alberta	High power laser discharge stabilization with magnetic fields * with C.E. Capjack, S.M. Robinson, P.R. Smy (Alberta) M. Cervenan, V. Merchant (Laser Institute)	180,000	41
Wallace,S.C. Physics/Chemistry Toronto	Next generation lasers using laser diode array excitation * with H.M. Van Driel, G.A. Kenney-Wallace (Toronto)	296,200	44
10. Integrated Systems, CAD/CAM, robotics / Systèmes intégrés, CAO/FAO, robots			
Buzacott,J.A. Management Sciences Waterloo	Modelling and application of just-in-time production systems * with R.G. Vickson, Y. Gerchak, F. Safayeni (Waterloo)	223,400	19
Fisher,D.G. Chemical Eng. Alberta	Applications of artificial intelligence in the process industries * with A.J. Morris (Alberta)	84,000	30
Fisher,D.G. Chemical Eng. Alberta	Adaptive Process Control * with A.J. Morris (Alberta)	136,850	31

* Total funds committed/Montant total accordé

SUMMARIES OF NEW PROJECTS / RÉSUMÉS DES NOUVEAUX PROJETS

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

☐ Biotechnology / Biotechnologie	☐ Communications and Computers / Télécommunications et informatique	☐ Energy / Énergie	☐ Environmental Toxicology Toxicologie de l'environnement
☐ Food-Agriculture / Alimentation-Agriculture	☑ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Océans	☐ Open / Ouvert

Name/Nom: MICHAEL M. AVEDESIAN

Department/Département: Chemical Eng.

University/Université: McGill

Phone number (optional)/N° de téléphone (facultatif):

Title of Project/Titre du projet: FLUIDIZED BED RECOVERY OF KRAFT BLACK LIQUOR - A NEW ALTERNATIVE

This work is an expansion of the existing three-year NSERC strategic grant titled "Fluidized Bed Recovery of Kraft Black Liquor".

The novel process concept around which this research revolves is designed to provide a safer, cheaper and more energy-efficient method of recovering the heat and chemical values in the Kraft process. The Kraft process is the major chemical pulping method used in the world today and is expected to maintain its dominance for years to come.

A bench-scale fluidized bed reactor system has been constructed at McGill University and will be used to gather essential process information to be used in a techno-economic evaluation of the novel process.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

☐ Biotechnology / Biotechnologie	☐ Communications and Computers / Télécommunications et informatique	☐ Energy / Énergie	☐ Environmental Toxicology Toxicologie de l'environnement
☐ Food-Agriculture / Alimentation-Agriculture	☒ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Océans	☐ Open / Ouvert

Name/Nom: Christopher W. Bale

Department/Département: Génie métallurgique

University/Université: Ecole Polytechnique de Montréal

Phone number (optional)/N° de téléphone (facultatif): (514) 340-4770

Title of Project/Titre du projet: « Calcium β-Alumina and Calcium Zirconium Orthophosphate Ionic Ceramics for Use as Chemical Sensors in Steelmaking »

Canadian steelmaking capacity is 0.8 tonnes/person/year or 20 million tonnes which pales in comparison with the Japanese capacity of 1.0 tonnes/person/year or 120 million tonnes. Both countries are presently operating at less than 75% capacity and so they must export in order to maintain facilities at satisfactory operating levels. The Japanese claim that they can keep total impurity levels (sulphur + oxygen + phosphorous, etc.) in their finished steels after refining, at less than 10 parts per million (by weight) whereas in Canada we have difficulty just trying to keep sulphur below 50 p.p.m. Since high impurities can adversely affect the properties and hence reliability of the finished steel, it is important that they be kept to a strict minimum.

In order for Canada to compete with off-shore (Japanese) imports, it is necessary for us to produce a better quality steel. The present proposal is to develop new solid-state materials called ionic ceramics which can act as chemical probes during the refining and "sense" impurity levels or concentrations in iron and steel melts. The device generates a small voltage which is proportional to the level of impurity. This may be fed into a computer which in turn directs operations for a better quality steel. This will give Canadian industry the necessary edge to compete with the imports.

Ionic ceramics (or superionics) are relatively new materials and as well as being chemical sensors, they can be used in other applications: high-temperature furnace elements, high energy-density batteries, thermoelectric generators, pressure and temperature sensors, electrochromic displays, just to name a few. In the proposal it is also intended that spin-off projects will be generated outside the field of iron and steelmaking.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

☐ Biotechnology / Biotechnologie	☐ Communications and Computers / Télécommunications et informatique	☐ Energy / Énergie	☐ Environmental Toxicology Toxicologie de l'environnement
☐ Food-Agriculture / Alimentation-Agriculture	☒ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Océans	☐ Open / Ouvert

Name/Nom: John A. Buzacott

Department/Département: Department of Management Sciences

University/Université: University of Waterloo

Phone number (optional)/N° de téléphone (facultatif): 519-888-4009

Title of Project/Titre du projet: "Modelling and Application of Just-In-Time Production Systems"

There has been a great deal of interest in Japanese approaches to production management and the transfer of these ideas to North American Industry. One of the specific approaches which is attracting considerable interest is Just-In-Time (JIT) Production Systems. This provides a means of maintaining tight control over the level of work in process inventory yet at the same time ensuring the smooth flow of production through the successive stages of manufacture. Key to the Japanese implementation of JIT is the use of KANBANs, cards whose release is triggered when an inventory falls by a specific amount. The KANBAN then travels back to the previous stage, authorizing the manufacture of a batch to replenish the depleted inventory.

The research proposed involves the development of models which can be used to plan and control JIT systems. It is also hoped that the insights gained from the models and also the close collaboration to be developed with industry will lead to the development of improved JIT systems which not only are superior to the Japanese approach but which also fit the organizational and other features of Canadian firms. The research is also intended to lead to the development of guidelines for the effective implementation of JIT in industry.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

- ☐ Biotechnology / Biotechnologie
- ☐ Communications and Computers / Télécommunications et informatique
- ☐ Energy / Énergie
- ☐ Environmental Toxicology / Toxicologie de l'environnement
- ☐ Food-Agriculture / Alimentation-Agriculture
- ☒ Industrial Materials and Processes / Matériaux et procédés industriels
- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: Howard Card

Department/Département: Electrical Engineering

University/Université: University of Manitoba

Phone number (optional)/N° de téléphone (facultatif): (204) 474-8521

Title of Project/Titre du projet: Microwave Plasma Deposition and Etching for VLSI

Plasma processing has become an essential technique for large scale integration (LSI) and (VLSI) fabrication. A new technique using a magentically confined microwave plasma has been developed in which the intensity of the magnetic field brings the plasma into electron cyclotron resonance (ECR). Interesting features of this system have already been demonstrated in the fabrication of thin films as well as in plasma etching of semiconductors and insulators. Advantages of this system are derived from departures from the usual plasma chemistry associated with conventional systems, as well as the additional versatility and plasma controlability afforded by varying the magnetic confinement of the plasma. The proposed studies will be directly related to dry etching properties such as selectivity, with direct applications in the fabrication of VLSI circuits where high-fidelity pattern transfer is a pre-requisite. In addition the proposed research will address low temperature deposition of both microcrystalline silicon and insulating thin films. Initial effort will be directed towards a silicon based technology with subsequent extension to a gallium arsenide technology.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

☐ Biotechnology / Biotechnologie	☐ Communications and Computers / Télécommunications et informatique	☐ Energy / Énergie	☐ Environmental Toxicology Toxicologie de l'environnement
☐ Food-Agriculture / Alimentation-Agriculture	☒ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Océans	☐ Open / Ouvert

Name/Nom: CARREAU, Pierre J.

Department/Département: Génie chimique

University/Université: Ecole Polytechnique de Montréal

Phone number (optional)/N° de téléphone (facultatif): 340-4924

Title of Project/Titre du projet: Extrusion des matériaux plastiques

Nous proposons d'étudier l'extrusion des matériaux plastiques renforcés ou non et les procédés connexes d'extrusion de profilés, soufflage de gaines, recouvrement de fils et cables, extrusion de plaques, feuilles et films. Les objectifs sont d'obtenir des données expérimentales essentielles à la modélisation des procédés, d'établir les relations entre les propriétés des produits finis, les caractéristiques des résines utilisées et les conditions de transformation, de mettre au point des logiciels capables de prévoir les performances des matériaux finis et d'adapter les logiciels pour exécution sur micro-ordinateurs. La qualité et les propriétés mécaniques des feuilles de thermoplastiques renforcés seront étudiées en fonction des conditions d'opération de l'extrusion. Le mica, minérai abondant au Québec, et autre fibres naturelles seront utilisés comme agents de renforcement. Aussi, comme les méthodes classiques d'éléments finis se butent à des problèmes de convergence lorsque l'on désire tenir compte du caractère viscoélastique des polymères, nous proposons d'étudier une approche nouvelle de simulation directe de l'écoulement des polymères. Cette approche pourrait éliminer les difficultés rencontrées.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

☐ Biotechnology / Biotechnologie	☐ Communications and Computers / Télécommunications et informatique	☐ Energy / Énergie	☐ Environmental Toxicology Toxicologie de l'environnement
☐ Food-Agriculture / Alimentation-Agriculture	☒ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Océans	☐ Open / Ouvert

Name/Nom: CHAKLADER, A.C.D.

Department/Département: Metallurgical Engineering

University/Université: University of British Columbia

Phone number (optional)/N° de téléphone (facultatif): (604) 228-2705 or 228-2676

Title of Project/Titre du projet: Plasma Synthesis of Sinterable SiC and Si_3N_4 Powders

Dr. Chaklader has published extensively in the field of ceramics over the last 25 years, covering a whole range of research projects. He has published so far 85 papers and another 10 papers are now being reviewed by different journals. His significant contributions are in the field of reactive hot-pressing (published papers - 22), metal-ceramic interfacial phenomena (8), model composite refractories (3), hot-pressing theories (7), cold compaction kinetics of brittle solids with liquid (5), and development of slag-resistant refractories for non-ferrous applications (2). Dr. Chaklader is also currently active in the research project on thermal shock behaviour of commercial refractories, synthesis of SiC and Si_3N_4 powders by D.C. arc, hot-pressing and sintering of SiC and Si_3N_4 powders, and finally automating the die-press system and testing of composite refractories.

SUMMARY FOR PUBLICATION/RÉSUMÉ À PUBLIER

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☐ Food-Agriculture / Alimentation-Agriculture	☑ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Océans	☐ Open / Ouvert

Name/Nom: Chavarie Claude

Department/Département: Génie Chimique

University/Université: Ecole Polytechnique de Montréal et University of British Columbia

Phone number (optional)/N° de téléphone (facultatif): (514) 340-4817

Title of Project/Titre du projet: Mise en oeuvre des catalyseurs d'aérogels en couches fluidisées et en lits circulants, développement d'un nouveau procédé d'hydrogénation et étude de la production de ces solides par lyophilisation.

Ce projet porte sur l'exploitation de nouveaux matériaux de haute technicité, les aérogels. Ces poudres d'oxydes inorganiques très légères (≈70 kg/m³), extraordinairement poreuses (>95% de vide) et très finement divisées (>20µm) sont susceptibles, comme catalyseurs industriels, de contribuer de façon significative au développement de nouvelles technologies pour l'industrie pétrochimique canadienne. Il est proposé de déterminer l'ingénierie et les paramètres de scale-up de deux procédés permettant de mettre à profit ces solides dans leur état naturel, l'un en couche fluidisée conventionnelle, l'autre en lit circulant (fast fluidized bed) pour les unités de grande capacité. Le potentiel d'applications de ces techniques comme systèmes réactionnels sera mis en évidence par le développement d'un nouveau procédé d'hydrogénation des hydrocarbures aromatiques sur l'aérogel Ni/Al_2O_3 en lit fluidisé. Cette réaction chimique permettra de compléter les recherches dans la mise au point d'une nouvelle technologie de stockage de l'hydrogène destinée aux moteurs à combustion. Il est enfin proposé de développer un procédé original pour la fabrication des aérogels par lyophilisation des solutions gélifiées à partir desquelles ces aérogels sont obtenus. Cette technologie aurait le double avantage d'être très sécuritaire en évitant les hautes pressions et températures des procédés en autoclave et, surtout, en permettant de remplacer les solvants alcooliques explosifs par simple utilisation de l'eau.

Ce projet repose sur l'effort concerté de chercheurs de l'Ecole Polytechnique de Montréal et de l'Université de la Colombie Britannique. Il se situe aussi dans le cadre d'une collaboration internationale impliquant des chercheurs de France et d'Angleterre.

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Name/Nom: W. R. Datars

Department/Département: Department of Physics

University/Université: McMaster University

Phone number (optional)/N° de téléphone (facultatif): (416) 525-9140, ext. 4173

Title of Project/Titre du projet: Physical Properties of Strained Layer Heterostructures

Molecular Beam Epitaxy (MBE) is a viable technique for growing epitaxial Si-band films. Superlattice structures can be made with alternate layers of Si and Si_xGe_{1-x} alloy. Many potential device and circuit applications have been proposed for these heterostructures. The research characterizes the heterostructures optical and electrical measurements. A new electron-hole gas in a two-dimensional state is investigated. Properties of the charge carriers in the heterostructures are determined and are related to potential applications.

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☐ Food-Agriculture / Alimentation-Agriculture	☒ Industrial Materials and Processes / Materiaux et procedes industriels	☐ Oceans / Oceans	☐ Open / Ouvert

Name/Nom: John M. Dealy

Department/Département: Chemical Engineering

University/Université: McGill University

Phone number (optional)/Nº de téléphone (facultatif): (514) 392-5442

Title of Project/Titre du projet:

THE USE OF RHEOLOGICAL SENSORS FOR PROCESS CONTROL IN THE PLASTICS INDUSTRY

Automatic control systems for use in the plastics industry make use of sensors that can detect temperature, pressure, drive motor speed and extrudate thickness. None of these provide information about the quality of the plastic resin being produced or processed. The applicant has developed a novel sensor that can detect the viscous and elastic properties of a molten plastic during its flow through processing machinery. This makes it possible, in principle, to control a polymerization reactor, a blending operation or a melt processing operation such as extrusion or molding, in such a way as to maintain constant some aspect of the resin's rheological behavior. This, in turn, would reduce waste, improve product uniformity and quality and increase efficiency.

However, before full advantage can be taken of the availability of the new in-line rheological sensor, it will be necessary to learn how variations in manipulated variables such as temperature and extruder screw speed influence the rheological properties of the molten product. In addition, it will be necessary to develop control strategies suitable for this application.

The present project has as its objectives to design and assemble an in-line process rheometer for process control and to use it to study the dynamic response of a plasticating extruder and to develop techniques for the automatic control of extrudate viscosity and elasticity.

This new technology will be useful to resin manufacturers and compounders and to large scale processors of plastics. For resin manufacturers its use will lead to reduced substandard resin and the production of resins custom-blended to have prescribed rheological properties. For fabricators, the technology will open the door to "precision extrusion" in which the production of a high quality product can be assured at all times.

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- ☒ Industrial Materials and Processes / Matériaux et procédés industriels
- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: de Lasa, Hugo

Department/Département: Chemical Engineering

University/Université: Western Ontario

Phone number (optional)/N° de téléphone (facultatif): (519) 661-2144

Title of Project/Titre du projet: Three Phase Fluidization at High Temperature and Pressure

In the present program, the hydrodynamics of three-phase fluidized beds with hydrocarbon fluids at high temperature and elevated pressure will be investigated. With this end, a novel fiber optic probe developed at the University of Western Ontario will be further refined and used extensively.

The results of the present program will provide a better understanding of three phase fluidized beds at high temperature and will allow to generate the required data for the design and operation of advanced three-phase fluidized bed reactors, as the one under development in the Alberta Research Council. The capability of the probe to operate at elevated temperatures will also be confirmed using reactor facilities of the Coal Research Department, Alberta Research Council, Edmonton.

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- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: R.A.L. Drew

Department/Département: Mining and Metallurgical Engineering

University/Université: McGill University

Phone number (optional)/N° de téléphone (facultatif): (514) 392-4581

Title of Project/Titre du projet: Development of Sialon Ceramics for High Temperature Applications

Advanced ceramic materials such as silicon nitride, silicon carbide and zirconium dioxide are presently receiving a great deal of attention because of their potential use as structural components for internal combustion and gas turbine engines. It is these materials ability to sustain mechanical loads at high temperature which will enable heat engines to operate at higher temperatures with the consequent advantages in terms of operating efficiency and fuel versatility.

Silicon nitride and its derivative the Sialons are of particular interest for high stress and temperature environments, where large thermal gradients and rapid temperature fluctuations are envisaged e.g. in engine valve components and injector nozzles. These materials are already finding use in less demanding applications such as welding hardware and metal cutting tools. However, the exacting properties for long-term reliability in the automotive sector have not yet been realized; the major drawbacks being cost and fabrication reliability of inherently brittle materials.

Research is underway to develop β'-sialons, the most promising of the sialon materials, to attain the physical properties and reliability required for the demanding environment of advanced heat engines. This study will deal with the fundamental aspects of synthesis of raw powders from precursors, their compaction, sintering and the influence of the ceramic preparation methods on the final ceramic microstructure and mechanical performance, particularly at high temperatures.

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Name/Nom: Dr. J.D. Embury

Department/Département: Materials Science & Engineering

University/Université: McMaster University

Phone number (optional)/N° de téléphone (facultatif): 416) 525-9140 ext. 4979

Title of Project/Titre du projet: Friction & Wear in Non-Metallic Materials

The proposal concerns new studies on the friction and wear of ceramic and amorphous materials. The objective is to understand the structural basis of wear processes and to optimize the production of the materials to reduce wear.

The study will encompass ceramics, amorphous materials and coated metals. The proposed work has potential application in the machine tool industries, high temperature structural ceramics applications for metallic glasses and materials for biotechnology.

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Name/Nom: FINCH, James Andrew

Department/Département: Mining and Metallurgical Engineering

University/Université: McGill University

Phone number (optional)/N° de téléphone (facultatif): (514) 392-5769

Title of Project/Titre du projet: MINERAL PROCESSING OF FINES

The objective is to continue development of a group for the solution of industrial fine particle processing problems. Three main areas are identified, mineral separation, comminution and applied mineralogy. Within these the specific topics are:

Mineral Separation

Column flotation. Novel bias control based on temperature; froth vibration to improve selectivity; general extension of column applications.

Wash water in mechanical cells. Evaluation on plant scale; optimization.

Electrochemistry in sulphide separation. Potential control (through N_2/O_2 or from potentiostat) for complex sulphide separation; galvanic effects in Cu/Pb separation as possible explanation of 'aging'; Eh as control parameter, notably in Cu/Zn separation.

Water quality in fine Nb flotation. Quantification of effects on dispersion, bubble coalescence and mineral depression; ozonation to remove residual organics.

Magnetic and gravity separation. Vibration hgms; cone/spiral combination to recover fine iron from tailings.

Comminution

Rod mill. Mill speed-up to reduce media consumption; fines addition to improve productivity (reduce operating work index).

Applied Mineralogy

Image analysis. Sample preparation; testing of standard among several groups; support for mineral separation projects.

The research will be of interest to all companies involved in mineral processing - metallic and non-metallic. Results are widely published and discussed at special seminars at McGill and at plant-site. The group is about 15 strong and actively engaged in co-operative work with some ten companies.

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Name/Nom: Professors D. Grant Fisher and A. Julian Morris

Department/Département: Chemical Engineering

University/Université: Alberta

Phone number (optional)/N° de téléphone (facultatif): 432-3301 and 432-3962

Title of Project/Titre du projet: Applications of Artificial Intelligence in the Process Industries

The purpose of this "applied research" proposal is to partially support a cooperative university-industry project dealing with the application of artificial (machine) intelligence to design, operational and control problems in process industries such as: oil refining, chemical production, food processing, cement, natural gas, tar sands, mineral processing and some continuous manufacturing plants. The requirement for *on-line, realtime* processing of sensor-based data plus interactive communication with the process operators distinguishes this work from most other AI projects. Our group will provide the AI plus technical knowledge and the equipment. Industry will supply the specialized application knowledge. Together we will combine AI plus application knowledge to produce prototype systems that will demonstrate the capabilities of AI and provide a basis for justifying full scale industrial applications.

We have already implemented an AI + fuzzy logic system; interfaced it to a process unit via a standard industrial controller; and presented the results at the 1985 CSChE national meeting and to industrial groups. There is a lot of industrial interest but most companies do not have the trained manpower, specialized equipment, nor real data to justify significant expenditures. We have a "state of the art" Hewlett Packard AI computer workstation; industrial groups have expressed an interest in working with us; we have four experienced people currently active in this area; and we are seeking NSERC support to partially pay the operating costs. The end results will be AI techniques and tools tailored to the process industry, trained manpower, and prototype AI systems solving industrial problems on real, pilot plant processes.

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Name/Nom: D. Grant Fisher and A. Julian Morris

Department/Département: Chemical Engineering

University/Université: Alberta

Phone number (optional)/Nº de téléphone (facultatif): (403) 432-3301 and 432-3962

Title of Project/Titre du projet: Adaptive Process Control

The objective of this project is to develop advanced adaptive control systems that will meet the needs of industrial users; to implement the resulting adaptive controllers on existing computer-controlled pilot plants; and to assist with the transfer of this technology to the process industries. This project will involve a significant amount of theoretical/mathematical development to take the best results from previous work by the co-investigators and by the international adaptive control community, and INTEGRATE them into a complete, consistent system. We are focusing on a complete, practical system for adaptive control in an industrial environment. This proposal is the result of:

1) a documented industrial need and interest
2) over 25 man-yr of experience by the co-investigatos in the area of adaptive control, documented by over 45 publications/presentations. Both investigators have industrial experience.
3) good communication with the international adaptive control community plus local and international industry
4) EXISTING computer controlled pilot plant processes that can be used to demonstrate the proposed adaptive controllers and EXPERIMENTALLY compare them with alternative control schemes (including the multi-loop, conventional computer control schemes used in most industrial applications: cf. our HP/1000/PMC system).
5) a detailed design and outline of what is required for a practical industrial controller based on current projects at the U of A plus interaction with industry.

A first-generation of commercial adaptive controllers and software is currently on the market. Although promising, the initial results support the need for broader design objectives (eg. safety, robustness, theoretical vs. ad hoc designs) plus a careful, complete implementation that considers practical industrial conditions (eg. noise, lack of process models, wide range of operating conditions). We plan to develop and demonstrate a practical single variable controller during 1987 and a multivariable adaptive controller during 1988 and 1989. The performance of these controllers will be demonstrated and compared with conventional controllers using a computer controlled pilot plant equipped with industrial instrumentation.

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- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: FOSCHI, Ricardo O.

Department/Département: Civil Engineering

University/Université: British Columbia

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Title of Project/Titre du projet: Structural Reliability of Systems with Wood-Based Materials

Current changes in structural design philosophy reflect a trend towards the adoption of probabilistic design methods and reliability-based design. The National Building Code of Canada has implemented such changes under the new "Limit States Design" recommendations for all structural materials. Design procedures for wood-based structural products are not yet reliability-based, and the development of background information for the implementation of such procedures is one of the main objectives of the present research. As such, the results will be used by CSA-086, the body responsible for the drafting of the Canadian Code for Engineering Design in Wood.

A second main objective is the development of a general methodology for the performance evaluation of wood-based structural materials, in relation to the target reliability of the intended use. In this sense, the methodology will serve: 1) to evaluate new or expanded applications for traditional products of Canada's forest industry; 2) to guide the development of new materials, manufactured from resources considered of lower value and/or quality; 3) to provide technical data on products and systems using those products, enhancing their marketability for engineered uses in internal and foreign markets; and 4) to guide the selection of appropriate quality control procedures and performance testing in relation to the reliability of the intended use.

The research project makes use of data from intensive testing programs conducted in the last few years by the Canadian industry, both for the short-term and long-term strength of lumber and panel products. Structural reliability is studied for systems, using structural analysis models implemented in computer programs and computer simulation. Systems considered are floor-type structures (floors, flat roofs, retaining walls for preserved wood foundations), walls and diaphragms under racking loads and earthquake-induced vibrations, pitched trusses, glued-laminated beams. Also considered is the reliability of Glulam Rivet connections, a fastener for use in glued-laminated construction.

Target reliabilities are recommended on the basis of performance of known system configurations, and performance factors are derived for the required Code design equations.

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Name/Nom: James E. Guillet

Department/Département: Chemistry

University/Université: Toronto

Phone number (optional)/N° de téléphone (facultatif): (416) 978-3591

Title of Project/Titre du projet: Polymers for Electronic Applications

Polymeric materials are being developed for use as photoresists in ultra-high resolution microcircuitry (alternatively known as very large scale integration, VLSI, technology) for use in a variety of advanced electronic devices. Plastic films will be exposed to deep ultraviolet radiation or soft x-rays in order to produce the necessary ultra-high resolution circuitry. Concurrent work involves investigation of the dissolution characteristics of irradiated and non-irradiated polymer films in order to improve development processes for these photoresists after irradiation.

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- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: S. Kaliaguine

Department/Département: Génie chimique

University/Université: Laval

Phone number (optional)/N° de téléphone (facultatif):

Title of Project/Titre du projet: Développement ou catalyseurs bi- et trifonctionnels à base d'oxydes de métaux de la famille du fer supportés sur une zéolithe.

La méthode de l'Adsorption d'Organométalliques en phase gazeuse développée récemment dans notre laboratoire sera utilisée systématiquement pour la préparation de catalyseurs. Ces catalyseurs comporteront un oxyde de fer, nickel ou cobalt déposé sur une des zéolithes suivantes: ZSM-5, silicalite, X et Y. Pour certaines applications on ajoutera à ces catalyseurs une fonction hydrogènante telle que palladium, rhodium ou platine. Les tests catalytiques seront répartis en trois sous-projets:

1) développement d'un catalyseur pour la réaction du gaz à l'eau (Water Gas Shift)
2) étude de l'activation du méthane
3) désoxygénation du méthanol en présence de CO.

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Name/Nom: Jean LESSARD

Department/Département: Département de chimie

University/Université: Université de Sherbrooke

Phone number (optional)/N° de téléphone (facultatif): (819) 821-7091 et 7098

Title of Project/Titre du projet: RECHERCHE DE "CHEMOSELECTIVITE" DANS L'ELECTROHYDROGENATION CATALYTIQUE DE MOLECULES ORGANIQUES A L'AIDE DE NOUVEAUX MATERIAUX D'ELECTRODES

L'électrohydrogénation catalytique de molécules organiques comprenant une ou plusieurs insaturations de types divers (doubles liaison carbone-carbone, carbone-oxygène, carbone-azote; triples liaisons carbone-carbone, carbone-azote; groupements nitro; etc) consiste à les faire réagir avec l'hydrogène chimisorbé produit à la surface d'une électrode par réduction électrochimique de l'eau: $nH_2O + 2\ ne^- \rightarrow 2\ nH^{\cdot}_{ads} + 2\ nHO^-$; $R + 2\ nH^{\cdot}_{ads} \rightarrow RH_{2n}$ (n = 1, 2, 3 ...). Les électrodes doivent posséder une faible surtension d'évolution d'hydrogène et une activité catalytique élevée, par exemple des électrodes composites à base de métaux de Raney.

Le but du projet est de trouver des électrodes permettant d'obtenir une grande sélectivité dans l'électrohydrogénation de divers groupements fonctionnels (chémosélectivité) et de comprendre les phénomènes responsables de la sélectivité (études mécanistiques sur l'évolution d'hydrogène et l'électrocatalyse, étude des phénomènes d'adsorption).

Nous allons préparer et étudier des matériaux d'électrodes à base d'un ou de plusieurs métaux de Raney (seul(s) ou dopé(s) avec d'autres métaux) et à base d'alliages amorphes (e.g. Ni-Zr, Ni-Ti, etc). Le comportement des diverses électrodes vis-à-vis une variété de groupements fonctionnels sera étudié: sélectivité et efficacité de l'électrohydrogénation, adsorption, mécanismes en jeu, etc. Les nouveaux matériaux seront caractérisés par des méthodes spectroscopiques et électrochimiques et leur stabilité et durabilité seront déterminées par des électrolyses en continu.

La chémosélectivité est l'un des problèmes majeurs de la synthèse organique et les connaissances et méthodes produites pourront être utilisées par les industries pharmaceutiques et les industries de fabrication de produits chimiques organiques. De plus les réactions électrochimiques sont propres (pas de réactif nocif et polluant utilisé) et généralement moins coûteuses que les réactions utilisant des réactifs rédox classiques.

Enfin les connaissances et méthodes développées pourront servir à l'électrohydrogénation des huiles lourdes (valorisation énergétique) et à transformer l'électricité en énergie chimique (hydrures organiques liquides) facile à emmagasiner et transporter.

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Name/Nom: LIPKOWSKI, Jacek

Department/Département: Department of Chemistry and Biochemistry

University/Université: University of Guelph, Guelph, Ontario. N1G 2W1

Phone number (optional)/N° de téléphone (facultatif): (519) 824-4120 Ext. 3969

Title of Project/Titre du projet:

Glassy metals as new electrocatalysts for fuel cells.

The aim of this work is to look for new catalysts for electrochemical energy conversion in fuel cells. Platinum is most frequently used for electrodes in fuel cells. Numerous studies have shown that the electrocatalytic activity of platinum is enhanced in alloys. Submonolayers of other metals deposited on platinum surfaces also enhance its reactivity. However, surface segregation, immiscibility gaps in the phase diagrams are factors which limit the performance of crystalline alloys. The objective of the present work is to use the new technique of rapid quenching of metals from the liquid or vapor phase to produce amorphous alloys of platinum as potential catalysts for fuel cells. If the quenching rate is higher than the crystallization rate, the thermodynamic constraints imposed by immiscibility gaps and surface can be overcome and alloys of homogeneous surface and bulk composition are produced. Surface composition of the alloys will be investigated by Auger Spectroscopy. Combined Auger and electrochemical experiments will be used to investigate the stability of the alloys toward (a) preferential dissolution of one of the components and (b) surface segregation and separation, under the influence of the electrode potential. The oxidation of hydrogen, carbon monoxide, methanol as well as reduction of oxygen on the amorphous alloys will be investigated. The relative reactivity of the amorphous alloys in respect to the reactivity of the crystalline samples and pure Pt will be estimated.

Over the short term, this work will provide information about the possibility of using rapidly quenched metals as new electrocatalysts. On the long term the prformance of rapidly quenched metals as electrode materials in fuel cells will be investigated.

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FIELD OF RESEARCH / DOMAINE DE RECHERCHE
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☐ Biotechnology / Biotechnologie	☐ Communications and Computers / Télécommunications et informatique	☐ Energy / Énergie	☐ Environmental Toxicology Toxicologie de l'environnement
☐ Food-Agriculture / Alimentation-Agriculture	☒ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Océans	☐ Open / Ouvert

Name/Nom: Alexander McLean

Department/Département: Metallurgy and Materials Science

University/Université: Toronto

Phone number (optional)/N° de téléphone (facultatif): (416)978-3552

Title of Project/Titre du projet: Tundish Metallurgy

Within the steelmaking system the tundish has been traditionally considered as an intermediate vessel between the ladle and the continuous caster . In this context the tundish served as a metal reservoir which provided a constant depth of steel and thus a constant casting rate. It also acted as a metal distributor between the ladle and the various molds. The ladle itself is a batch reactor and during the last fifteen years considerable research was performed on the subject of ladle metallurgy. Today many Canadian steel companies are actively involved in processes of this type. On the other hand, the tundish is a continuous reactor but unfortunately, in many plants the tundish behaves as a continuous metal contaminator rather than a refiner. This means that much of the quality built into the steel while in the furnace and during ladle treatment is lost in the tundish and attempts have then to be made to recover this lost quality in the casting mold. This places undue demands on the mold flux which must then absorb excessive amounts of reaction products carried over from the tundish and this in turn adversely affects heat transfer conditions in the mold. This can result in poor surface quality and the formation of cracks in the cast steel product, or if conditions are particularly bad, a break-out of liquid metal can occur, resulting in a loss of production and possible damage to the caster. If however, the tundish is used as a continuous refiner, certain metallurgical operations which are presently performed in the ladle could be transferred with advantage to the tundish. In addition, if the tundish is designed as a refiner this will simplify operations in the mold and place less demand on the mold flux. Using this strategy, metallurgical operations can be optimized so that improvement in quality is progressively built into the steel as it moves from the furnace, into the ladle, through the tundish and on into the mold.

The technical objectives of this research project are three fold: a) The development of appropriate alloys for tundish additions; b) The development of synthetic slags as tundish refining agents and c) On-line evaluation of the quality of molten steel in the tundish using an ultrasonic monitoring device.

Based on the excellent relationships which exist between the university and the Canadian steel industry, the transfer of results from the laboratory to production will be enhanced. In addition to the socio-economic advantages, graduate students engaged in this project will benefit directly by working in association with senior university reseachers as well as industrial personnel. All of these aspects will contribute to the implementation of new technology which should result in improved steel quality and metal yield as well as materials and energy conservation.

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☐ Biotechnology / Biotechnologie	☐ Communications and Computers / Télécommunications et informatique	☐ Energy / Énergie	☐ Environmental Topocology / Toxicologie de l'environnement
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Name/Nom: J.B. Moffat

Department/Département: Chemistry

University/Université: University of Waterloo

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Title of Project/Titre du projet: Selective Conversion of Methane on Designed Heteropoly Oxometalates

Canada is fortunate in having abundant supplies of natural gas. Currently approximately 25% of our production is exported, primarily to the United States. Much of the natural gas is employed in this country as a fuel in stationary applications, although there is increased use in the form of compressed natural gas as a vehicle fuel. However gasoline continues to be the most convenient combustible mixture for the latter purposes. Unfortunately methane has enjoyed relatively little use as a chemical raw material partly as a consequence of its state under ambient conditions but largely as a consequence of its resistance to selective conversion. While the total oxidation of methane to carbon monoxide and/or carbon dioxide occurs readily, its partial oxidation to liquids such as formaldehyde and methanol is much more difficult.

The work for which support is requested in this proposal is concerned with the use of heterogeneous catalysts to direct the conversion of methane toward the more desirable products of oxidation. Work in this laboratory has shown that heteropoly oxometalates are solids whose catalytic properties may be altered by variation of the elemental composition of the anion and/or cation. In the present work catalyst composition as well as reaction variables will be investigated in the selective oxidation of methane.

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Name/Nom: Dr. P.S. NICHOLSON

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University/Université: McMASTER UNIVERSITY

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Title of Project/Titre du projet: SYNTHESIS OF TEXTURED AlN POLYCRYSTALS FOR HIGH FREQUENCY ULTRASONIC TRANSDUCERS

Ceramic materials are being introduced into heat engines, electronic devices, biological implants and other high performance locations. As with the materials they are replacing, it is vital to nondestructively evaluate these ceramic components to guarantee their reliability. This poses a major problem as the damaging defects are $\leq 10\,\mu m$ in size. This research addresses the problem of developing transducers capable of detecting these defects. Ultrasonic inspection is an established tool for visualising defects in opaque bodies. It is used in medicine for fetal examination, in metallurgy for metal inspection and to detect submarines and fish in the oceans. As its frequency increases, the detection limit of ultrasound increases but its absorption by the medium through which it travels also increases. To detect the $10\,\mu m$ flaws in ceramics therefore, high frequency (100 MHz), high power ($\sim$1 cm diameter) ultrasonic transducers are required. The ultrasound is generated by a very thin ceramic element inside the transducer. To generate 100 MHz at high power, the dielectric constant and loss of the ceramic element must be low and its dielectric strength and speed of sound very high. Aluminum nitride is such a material and this research will lead to development of AlN-based 100 MHz/high power transducers. The AlN will be produced by CVD and powder densification techniques and the dense elements will be piezoelectrically characterized. Optimal elements will be built into ultrasonic transducers and the transducer characteristics determined.

Two Canadian companies, Alcan International and B M HiTech Ltd., have a commercial interest in the project results, the former as a supplier of high quality AlN powders and the latter as a manufacturer of piezoelectric ceramics and high frequency transducers.

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Name/Nom: SAMARASEKERA, Indira

Department/Département: Metallurgical Engineering

University/Université: University of British Columbia

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Title of Project/Titre du projet: Microstructural Evolution During Hot Rolling of Steel

A research programme has been initiated in the Centre for Metallurgical Process Engineering at the University of British Columbia to predict the thermal and metallurgical state (defined by the microstructure) of steel during finish rolling and subsequent cooling and coiling in a hot-strip mill. During this operation the steel is progressively reduced in thickness at each roll stand and subsequently undergoes a phase-transformation on the run-out table prior to coiling. The objectives of the research will be accomplished by developing mathematical models to predict the thermal history, stress/strain distribution and microstructural state of the strip as a function of mill parameters. Vital to the modelling work is data on the hot-deformation behaviour of steel, transformation and recrystallization kinetics. This information will be independently obtained for high strength low alloys, dual-phase and plain carbon steels through test programmes at Canmet, U.B.C. and McGill University. The predictive capability of the models will be assessed by comparing model predictions with in-plant measurements at Stelco's hot-strip mill at Lake Erie Works. The models will be employed todesign reduction schedules, and select speeds, finish mill entry temperature, run-out table cooling conditions, and coiling temperatures, required to produce strip with desired structure and mechanical properties for each grade.

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- ☒ Industrial Materials and Processes / Matériaux et procédés industriels
- ☐ Oceans / Océans
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University/Université: UNIVERSITY OF ALBERTA

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Title of Project/Titre du projet: HIGH POWER LASER DISCHARGE STABILIZATION WITH MAGNETIC FIELDS

The distributed high pressure "Glow Discharge" has long been of great interest to workers in the high powered laser field. This is so, because this type of electrical gas discharge has been found to be particularly convenient in pumping large volume CW CO2 lasers; which in turn have demonstrated a significant potential in the rapidly expanding field of LASER MATERIALS PROCESSING.

High pressure glow discharge technology, as applied to these high powered CW lasers, has in actual practice been fraught with considerable difficulty. This has been the case, since to achieve effective laser pumping one desires a large volume and distributed high current glow, in a relative high pressure mixture of electro-negative gases. The major impediment to attainment of this condition has been identified , both experimentally and theoretically, to be an electro-thermally induced glow-to-arc transition; a phenomenon by which an initially uniform, distributed glow suddenly collapses into a constricted and usually catastrophic arc.

Over the years many techniques have been proposed and several implemented to suppress or at least further extend the power threshold for the onset of these glow-to-arc manifestations. Unfortunately most of these techniques have been either, very expensive, complicated, or ineffective.

After many years of study, analysis and experimentation we believe that we have made a significant advance in this important area. Specifically, we have developed an entirely new method of glow discharge stabilization; which not only overcomes these electrode glow-to arc transitions, but in addition appears to significantly suppress electro-thermal instabilities in the bulk plasma as well.

Basically the technique involves the application of specially profiled radial and axial magnetic fields, to interact with the discharge current itself, and particularly with the electron and ion space charge sheaths at or near the electrodes surfaces. The LORENTZ forces so produced on the moving charge particle streams, cause an intense plasma interaction. The overall effect is the production of a high velocity sheared flow, with a concomitant mixing effect within these space charge regions. This condition inhibits the formation and/or growth of local nonuniformities at the electrode surfaces and in the plasma bulk. The net result is the attainment of a uniform distributed glow discharge of high specific power loading; particularly suitable for laser excitation.

The effectiveness of the process has now been demonstrated in a number of discharge geometries. More recently a completely new type of medium power CW CO2 laser, a MAGPIE laser, has been designed and built. This unit utilizes our magnetic discharge stabilization process in a compact coaxial electrode configuration. The further development, perfection and application of the approach to other and more powerful laser systems is the primary objective of this continuing research program.

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Name/Nom: Iain D. Sommerville

Department/Département: Metallurgy and Materials Science

University/Université: Toronto

Phone number (optional)/N° de téléphone (facultatif): (416) 978-3552

Title of Project/Titre du projet: Optimization of Weld Metal Properties Through Control of Flux Chemistry

The presence of hydrogen, sulphur and oxygen in weld metal is known to have detrimental effects on the mechanical properties and integrity of welds. Hydrogen is associated with susceptibility to cracking, while both sulphur and oxygen produce inclusions which adversely affect the toughness of the weld metal. It is known that the flux composition plays an important part in determining the residual contents of these three elements in the weld deposit, but until now the means of quantifying this connection has been lacking.

Recent advances in our understanding of gas-slag-metal interactions during steel-making and ladle treatments have indicated ways in which greater control might be exercised over the content of these residual elements during flux-shielded arc welding operations. More specifically, the concept of optical basicity, the value of which can be calculated for any oxide flux, has provided a means of rationalizing all the known data on the sulphide and water capacities of oxide fluxes, and hence permitted calculation of the residual hydrogen and sulphur contents of the metal at slag-metal equilibrium, provided that the temperature and oxygen potential of the slag-metal system can be calculated or reasonably accurately estimated. If it can be demonstrated through specifically designed experiments that this approach is applicable to the welding situation, then not only would this represent a significant advance in our understanding of elemental transfer during arc welding, but major cost savings would result.

Hydrogen-induced cracking is a key problem in welds in constructional steels. Much work has been carried out in this area in terms of modifying flux formulations, (essentially be removing moisture-bearing constituents such as kaolinite), using carefully-controlled electrode baking procedures, and different plate preheating levels (to avoid formation of brittle microstructural constituents in the heat-affected zone). In this program the approach taken will involve a more fundamental approach to the question of hydrogen absorption in weld pools, by evaluating the optical basicity of the fluxes employed and the roles played by surface active constituents such as sulphur and oxygen in deposits. The main thrusts will involve:
(a) Evaluation of the connection between flux composition and hydrogen absorption in weld pool by application of the optical basicity concept.
(b) Evaluation of flux composition and sulphur partition in welding by application of the optical basicity concept.
(c) Evaluation of the interaction between hydrogen, sulphur and oxygen during arc welding and determination of the optimum conditions for the minimization of diffusable hydrogen levels and hence hydrogen-induced cracking in weld metal deposits.

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Name/Nom: D. A. Thompson, P. E. Jessop, B. K. Garside, J. A. Davies

Department/Département: Engineering Physics

University/Université: McMaster University

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Title of Project/Titre du projet: Strained layers and strained layer superlattice structures for device applications.

Recent advances in epitaxial growth techniques have made possible the fabrication of good quality films of tertiary and quatenary III-V semiconducting alloys lattice matched to their substrate material. By varying the alloy composition whilst maintaining lattice matching it is possible to modify the energy gap and produce heterojunction structures suitable for optoelectronic devices operating at tailored wavelengths. An extra degree of flexibility in wavelength (i.e. energy gap) control can be achieved using strained layer structures where the lattice matching requirement is relaxed. It is the objective of this proposal to study such strained layers and strained layer superlattices to correlate the effects of strain to the electrical and optical properties of the layers. Also specific device capabilities will be established through the development of high speed, low noise photodetectors using such structures. Key diagnostic techniques will include: Rutherford backscattering/channeling which has been shown to be an extremely sensitive technique to probe lattice distoritions due to strain, optical measurements including Raman spectroscopy and modulated reflectance, electrical measurements (Hall effect, conductivity) with a range of compositional and structural measurements (TEM,Auger, EDAX, X-ray). The InGaAs/GaAs and GeSi/Si systems will be studied for their application to optoelectronic devices operating in the 1-1.7 μm range. These studies will involve collaboration with Bell Northern Research and the Microstructural Sciences Division of NRC. Using our own hot wall epitaxy facilities, lead salt SLS structures will be studied for their application to larger wavelength devices.

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Name/Nom: WALLACE, Stephen C.

Department/Département: Chemistry and Physics

University/Université: Toronto

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Title of Project/Titre du projet: Next Generation Lasers using Laser Diode Array Excitation

A new generation of lasers, based on semiconductor laser diode pumped rare earth solid state (RESS) lasers will be developed. These offer significantly improved electrical efficiency, reliability, stability, and compactness over the conventional flash-lamp pumped RESS lasers currently in use in industrial and scienfitic applications. With intracavity frequency doubling, these lasers will produce visible radiation, which can be used in a wide range of applications such as displays, reprographics, holography, and remote sensing. These laser systems will be all "solid state", require no water cooling, and be significantly more efficient than conventional devices available at present.

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☐ Food-Agriculture / Alimentation-Agriculture	☑ Industrial Materials and Processes / Matériaux et procédés industriels	☐ Oceans / Océans	☐ Open / Ouvert

Name/Nom: Jeffrey K. S. Wan

Department/Département: Chemistry

University/Université: Queen's University

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Title of Project/Titre du projet: CHEMICAL APPLICATIONS OF MICROWAVE TECHNOLOGY IN INDUSTRIAL PROCESSES

A large number of industrial chemical and material processes employ the technique of catalysis and energy sensitizer to increase the chemical/energy efficiency. In the fields of chemical catalysis and material processing two fundamental areas are amenable to innovation: (1) a new approach to energy utilization; and (2) development of unique economical chemical processes by utilizing the vast reserve of methane in Canada. Combining these two innovative approaches we have been working on the development of a microwave catalytic technology for industrial use. The basic concept and the great advantages of the chemical microwave technique have recently been demonstrated at Queen's by a number of model experiments, including the economical conversion of methane to ethylene (US patent 4574038), the low pressure/temperature hydrodesulfurization of pitch (US patent 4545879), the solid dechlorination of organic waste (US patent 4345983), and the surprising success of producing methanol from methane and water in a microwave catalytic reactor. In order to promote direct technology transfer to industrial use, we propose to devote some of our expertise and experience to work along with industry to design a pilot industrial type stainless steel microwave catalytic reactor to be tested in an industrial laboratory. To open new areas of applications and to develop new thoughts in this innovative technology, we propose to understake a detailed theoretical study on the effects of microwave radiation on a metallic catalytic surface with an accompanied estimate of the transient surface temperatures during the microwave catalysis. An excimer high power laser has been installed at Queen's to study the creation of surface imperfections on catalytic metallic surfaces and their effects on microwave fields and chemical activities. This aspect of our proposed study will shed some light on the surface chemical activity and how existing catalysts can be modified for microwave experiments. Two new model systems are proposed for further microwave catalytic studies: (1) a comparative study of the thermal-neutral reaction of methane and NO to produce ammonia; it will serve as a model for future nitrogen fixation reactions and syntheses of organic amines; (2) a preliminary demonstration of the potential microwave catalytic techniques in the fusion of metal fibres in silicon and organic polymers. During the three-year period of this proposed study, we plan to organize a university/industry user workshop to promote the understanding and to demonstrate the simple microwave catalytic technology amenable to industrial applications.

Canada has a large surplus of methane. We hope that the microwave catalytic processing of methane into various useful chemical stocks such as ethylene and ammonia will benefit the national economy. The scientific efforts will also provide Canada with the cutting edge in the development of microwave chemical technology.

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- ☒ Industrial Materials and Processes / Matériaux et procédés industriels
- ☐ Oceans / Océans
- ☐ Open / Ouvert

Name/Nom: M.A. Winnik
Department/Département: Chemistry
University/Université: Toronto
Phone number (optional)/N° de téléphone (facultatif):

Title of Project/Titre du projet: **Design of better polymeric materials for use as floculants and pusher fluids**

NSERC has awarded a grant of $350,000 over a three-year period to five scientists at the University of Toronto to study the use of polymers in various aspects of oil recovery. The group, headed by Chemistry Professor M. A. Winnik, includes three chemists, W. F. Reynolds, S. G. Whittington and J. E. Guillet, and one Mechanical Engineer, D. F. James. These scientists will address two problems of major concern to the oil industry.

The first concerns the role of pusher fluids for enhanced oil recovery. When oil is pumped from the ground, something must replace the oil drawn out, or else a void will form under the ground. A surfactant solution is used for this purpose, followed by a pusher fluid to maintain the pressure necessary to pump the oil to the surface. A surfactant is any substance introduced into a liquid to lower its surface tension, and a pusher fluid is usually water with polymers added to give it the desired properties. The interactions between the surfactants and the pusher fluids and how they are influenced by shear and other flow dynamics as the fluid is forced through pores in the rock is of intense interest in the area of enhanced oil recovery. Understanding these complex processes depends on an understanding of the physical and chemical dynamics at the molecular level. Winnik and his colleagues hope to advance our knowledge in this area.

The second area to be addressed by the Toronto group will involve the use of flocculants to settle the solid materials held in suspension in tailings ponds. One of Canada's most serious environmental problems is related to the extraction process from the Alberta tar sands. The process uses large quantities of hot water to separate bitumen from the clay and sand. After separation, the water is discharged into huge tailings ponds (some over 20 kilometers square). Water in these tailings ponds holds a suspension of fine clay and sand, as well as residual bitumen, thus making it unuseable for any purpose. If the water could be cleaned, and the bitumen recovered, there not only would be a considerable economic benefit to the oil industry, but also an important environmental benefit, since less water would be required and less land space needed for tailings ponds.

What is needed is a process which will settle the solid waste materials and promote water recovery. Guillet already holds a patent on a polymeric flocculant for use in tar sands extraction. ..... Winnik and his coworkers now build on this previous work and extend it into the use of other techniques for effective flocculation. Both theoretical and experimental avenues of research will be pursued.

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Title of Project/Titre du projet: BASIC INVESTIGATION OF METAL CUTTING MECHANICS AND TOOL WEAR.

The applicants intend to develop a simple predictive model of the metalcutting process which incorporates both material workhardening and the influence of the elastic portion of rake face force. While it is presumed that the analytical model will derive from a slip line field solution, considerable effort will be expended to develop a large strain finite element model of the process for the purpose of comparison.

In addition to the work in analysing the process it is intended to develop new experimental equipment for the following purposes.

1) A split tool dynamometer which will allow measurement of stresses in both the plastic and elastic contact zones on the tool.
2) An improved "quick step" device to allow the preparation of chip roots for later analysis using the scanning electron microscope. This device then allows the examination of flow zone geometry and is important in the study of second phase particle behaviour within the flow zones.

Finally a detailed experimental analysis of the relationship between tool wear mode and rate of wear with prevalent stress and temperature will be undertaken. This exercise will be primarily concerned with simple WC-Co tools, the extension, of such work to interrupted cutting will be briefly examined.

The applicants believe that the fundamental work described above will considerably aid more applied research efforts concerned with the improvement of productivity of metal cutting machine tools.

LIST OF ON-GOING RESEARCH PROJECTS / LISTE DES PROJETS DE RECHERCHE EN COURS

Industrial Materials and Processes / Matériaux et procédés industriels

Name/Nom Department/Département University/Université	Title/titre	$*
1. Polymers and Composites / Polymères et composites		
Durocher,G. Chimie Montréal	Préparation et étude physique de nouveaux polymères photoconducteurs à base de monomères donneurs-accepteurs * avec D. Gravel (Montréal)	156,000
Frechet,J.M.J. Chemistry Ottawa	Novel charge-transport polymeric materials	103,200
Hamielec,A.E. Chemical Eng. McMaster	Dynamics of runaway adiabatic polymerizations * with J.F. MacGregor (McMaster)	119,727
Harrod,J.F. Chemistry McGill	Catalytic polymerization of silane and organosilanes	117,000
Kamal,M.R. Chemical Eng. McGill	Applications of CAD/CAM/CAE finite element models to plastics processing * with J.M. Dealy, W.I. Patterson, B.R. Baliga (McGill), P.J. Carreau (Montréal)	172,479
Nadeau,J.S. Metallurgical Eng. British Columbia	Hybrid composite materials made with ultra-high modulus polyethylene fibres * with E. Teghtsoonian (UBC)	180,000
Rudin,A. Chem. & Chem. Eng. Waterloo	Crosslinking reactions of thermosetting polymers	142,500
Rudin,A. Chem. & Chem. Eng. Waterloo	Initiated thermo-oxidative reactions of polyolefins * with H.P. Schreiber (Ecole Poly.)	119,750
Schneider,M.H. Forest Resources New Brunswick	Wood-polymer composites	209,928

* Total funds committed/Montant total accordé

Industrial Materials and Processes / Matériaux et procédés industriels

Name/Nom Department/Département University/Université	Title/titre	$*
1. Polymers and Composites / Polymères et composites		
Schreiber,H.P. Chemistry Ecole Polytechnique	Property control in polar-group-containing polymers * with P.F. Bataille, P.J. Carreau (Ecole Poly.)	240,000
Vlachopoulos,J. Chemical Eng. McMaster	Finite element methods for CAD/CAM in polymer processing * with A.N. Hrymak, F.A. Mirza (McMaster)	205,500
Wood,P.E. Chemical Eng. McMaster	Studies in reaction injection molding * with A.N. Hrymak, J.F. MacGregor, A.E. Hamielec (McMaster)	162,000
2. Semiconductors / Semi-conducteurs		
Haslett,J.W. Electrical Eng. Calgary	High temperature analog and digital circuits for energy related instrumentation * with K.V.I. Kaler, F.N. Trofimenkoff (Calgary)	198,000
Puddephatt,R.J. Chemistry Western Ontario	Organometallic compounds in chemical vapour deposition	129,000
Thompson,D.A. Eng. Physics McMaster	Ion implantation processing in GaAs and other III-V semi-conductors * with P.E. Jessop (McMaster)	113,559

* Total funds committed/Montant total accordé

Name/Nom Department/Département University/Université	Title/titre	$*
3. Ceramics and Cements / Céramiques et ciments		
Aitcin,P.C. Génie civil Sherbrooke	Développement de mortiers et bétons spéciaux à base de fumées de silice	119,800
Johari,G.P. Metal/Mat. Science McMaster	Studies of mechanical strength and ultraviolet absorption of commercial glass	191,688
Nicholson,P.S. Metal/Mat. Science McMaster	The characterisation and improvement of hydronium B/B"-Alumina electrolytes for steam electrolysis applications	150,000
Wilkinson,D.S. Metal/Mat. Science McMaster	Ceramic materials for heat engine applications	171,623
4. Coatings / Revêtments		
Colbow,K. Physics Simon Fraser	Studies of SnO_2 films for heat reflecting coatings on windows * with S.R. Morrison, B.P. Clayman (SFU)	137,680
Parsons,R.R. Physics British Columbia	Automated in-line biplanar sputtering system * with J. Rostworowski (Corona Vacuum Coaters)	152,000
5. Cellulosics / Cellulosiques		
Manley,R.S.J. Chemistry McGill	Modification of pulp and paper properties by alteration of cellulose ultrastructure * with J.F. Revol (PAPRICAN)	123,000

* Total funds committed/Montant total accordé

Name/Nom Department/Département University/Université	Title/titre	$*
6. Metals and Metallurgical Process / Métaux et procédés métallurgiques		
Akben,M.G. Mining/Metal. Eng. McGill	Development of microalloyed steels for Arctic, offshore and industrial applications * with J.J. Jonas (McGill), H.J. McQueen (Concordia) G. L'Espérance (Ecole Poly.)	180,000
Chang,J.S. Eng. Physics McMaster	Studies of plasma-preheating and coal powder/steam injection techniques for metallurgical processings * with G.A. Irons, W.K. Lu, A.A. Berezin (McMaster)	164,000
Gruzleski,J. Mining/Metal. Eng. McGill	The development of sensors for the control of metallurgical processes * with W.M. Williams, F. Mucciardi (McGill)	188,000
Guthrie,R.I.L. Mining/Metal. Eng. McGill	Optimization of metallurgical processes * with M. Salcudean (UBC)	200,400
Hutchins,D.A. Physics Queen's	A laser EMAT defect detection system for hot metal	87,700
Jonas,J.J. Metallurgical Eng. McGill	Improved methods for the characterization of textures and material anisotropy in commercial materials	151,900
Lee,G.M.C. Mining/Metal. Eng. Tech. Univ. N.S.	Cast structural steels for offshore construction and mining applications * with K.G. Leewis (TUNS)	180,000
Lenard,J.G. Mechanical Eng. New Brunswick	Development of information required for adaptive control of hot strip mills * with D.R. Morris (UNB), A.B. Mitchell (RPC of N.B.)	121,000
Lu,W.K. Metallurgy McMaster	Research and development on the manufacture of fluxed iron ore agglomerates for the blast furnace	140,400
Lu,W.K. Metallurgy McMaster	Hydrogen in blast furnace ironmaking	63,300

* Total funds committed/Montant total accordé

Name/Nom Department/Département University/Université	Title/titre	$*
6. Metals and Metallurgical Process / Métaux et procédés métallurgiques		
Miller,J.M. Chemistry Brock	Metal extraction and recovery via phosphine chemicals	87,000
Mitchell,A. Metallurgical Eng. British Columbia	Novel alloy systems	122,800
Neale,K.W. Génie civil Sherbrooke	Modélisation de la formabilité des tôles métalliques et des polymères	133,680
Purdy,G.R. Metal/Mat. Science McMaster	The solidification processing of steels * with J.D. Embury (McMaster)	143,749
Tromans,D. Metallurgical Eng. British Columbia	Cracking of steel in caustic solutions - Kraft and Bayer processes	105,000
Weinberg,F. Metallurgical Eng. British Columbia	Spangle solidification in hot dip galvanizing of steel * with J.E. Lait (UBC)	179,400
Wynnyckyj,J.R. Chemical Eng. Waterloo	Bench-scale study of an advanced-technology magnesium winning process	232,820
7. Catalysts and Catalytic Processes / Catalyseurs et procédés catalytiques		
Baird,M.C. Chemistry Queen's	Shape-selective Fischer-Tropsch catalysis	86,250
DeLasa,H.I. Chemical Eng. Western Ontario	Advanced technology for catalytic cracking processes	153,452
Lever,A.B.P. Chemistry York	Multi-electron electrocatalysts for fuel cells * with C.C. Leznoff (York)	240,000

* Total funds committed/Montant total accordé

Industrial Materials and Processes / Matériaux et procédés industriels

Name/Nom Department/Département University/Université	Title/titre	$*
7. Catalysts and Catalytic Processes / Catalyseurs et procédés catalytiques		
Moffat,J.B. Chemistry Waterloo	New shape-selective catalysts	135,000
Taylor,P.A. Chemical Eng. McMaster	Computer control of gas phase catalytic reactors * with J.F. MacGregor, J.D. Wright, A.N. Hrymak (McMaster)	157,650
8. Pulp and Paper Processes / Procédés de transformation des pâtes et papiers		
Gauvin,W.H. Chemical Eng. McGill	Novel application of steam plasma and reactor geometry for black liquor recovery	92,200
Koran,Z. Pâtes et papiers Qué.-Trois-Riv.	Valorisation des pâtes mécaniques dans l'industrie des cartons	117,000
Lapointe,M.U. Pâtes et papiers Qué.-Trois-Riv.	Les pâtes à très haut rendement de pin gris * avec M. Barbe, K.N. Law (UQTR)	172,500
Mason,S.G. Chemistry McGill	Retention of fiber fines and fillers in papermaking * with T.G.M. Van de Ven (McGill)	174,000
9. Novel processes / Nouveaux procédés		
Ackman,R.G. Engineering Tech. Univ. N.S.	Cod liver oil: Pilot plant production of fractions enriched in eicosapentaenoic and docosa-hexaenoic acids	180,000
Baird,M.H.I. Chemical Eng. McMaster	Solvent extraction aided by 10-200 Hz vibrations * with S. Vijayan (McMaster)	102,119

* Total funds committed/Montant total accordé

Name/Nom Department/Département University/Université	Title/titre	$*
9. Novel processes / Nouveaux procédés		
Otto,F.D. Chemical Eng. Alberta	Selective gas treating * with A.E. Mather (Alberta)	194,840
Polanyi,J.C. Chemistry Toronto	Laser writing, etching and doping	189,000
Tulip,J. Electrical Eng. Alberta	High powered waveguide CO2 laser	195,000
Wanke,S.E. Chemical Eng. Alberta	Optimal chemical routes for heavy oil upgrading * with I.G. Dalla Lana, M.R. Gray (Alberta)	213,360
10. Integratred Systems, CAD/CAM, robotics / Systèmes intégrés, CAO/FAO, robots		
Buzacott,J.A. Management Sciences Waterloo	Planning and operation of integrated manufacturing systems * with J.B. Moore, M.J. Magazine, G.R. Sullivan, R.G. Vickson, I. Bernhardt, J.H. Bookbinder (Waterloo)	222,000
Gaines,B.R. Industrial Eng. Toronto	Management of new industrial technology * with H.F. Kolodny, N. Moray, I.B. Turksen (Toronto)	156,000
Goldak,J. Mech. & Aeronaut. Carleton	A geometric/kinematic/dynamic knowledge base for CAD/CAM * with M.J. Bibby, S.A. Sjolander, J.Z. Sasiadek, N.M. Holtz, J.L. Humar, J.J. Salinas, E. Menipaz (Carleton)	236,500
Lawrence,P.D. Electrical Eng. British Columbia	Telerobot interfaces for machine operation * with P.L. Cottell (MacMillan Bloedel), M.R. Ito (UBC)	462,268
Russell,A.D. Civil Engineering British Columbia	Advanced planning technologies for construction productivity improvement * with W.F. Caselton (UBC)	88,500
Stepanenko,Y. Mechanical Eng. Waterloo	A new breed of intelligent robotic manipulators with a compliant 'hierarchy of stereo-types' control * with T.S. Sankar (Concordia)	171,300

* Total funds committed/Montant total accordé

LIST OF COMPLETED RESEARCH PROJECTS /
LISTE DES PROJETS DE RECHERCHE TERMINÉS

Industrial Materials and Processes / Matériaux et procédés industriels

Name/Nom Department/Département University/Université	Title/titre	$*	Page
1. Polymers and Composites / Polymères et composites			
Belanger,P.A. Physique Laval	Application du laser submillimétrique dans l'industrie des matériaux en feuille * avec P. Bernard (Ottawa), R. Boulay (Laval)	70,000	70
Funt,B.L. Chemistry Simon Fraser	Electrochemical preparation of conducting polymers	106,230	77
Kokta,B.V. Centre de recherche en pâtes et papiers Qué-à-Trois-Riv.	Composites de polymères thermoplastiques et de fibres de bois	56,166	83
Nadeau,J.S. Metallurgical Eng. British Columbia	Delayed failure of composite * with E. Tegthsoonian, R.J. Gray (UBC)	180,000	85
Passmore,J. Chemistry New Brunswick	The preparation and characterisation of novel conducting polymers and related materials	123,912	87
Woodhams,R.T. Chemical Eng. Toronto	Ordered polymers by solid phase processing * with C.E. Chaffey, S.T. Balke, D. McCammond, A.B. Perrin, G.C. Weatherly (Toronto)	50,000	90
2. Semiconductors / Semi-conducteurs			
Weinberg,F. Metallurgical Eng. British Columbia	The growth of crystals for the electronic industry * with I.V. Samarasekera (UBC)	227,000	89
3. Ceramics and Cements / Céramiques et ciments			
Nicholson,P.S. Metal/Mat. Science McMaster	Improved piezoelectric ceramics for high frequency ultrasonic transducers	93,760	86

* Total funds awarded/Montant total accordé

Name/Nom Department/Département University/Université	Title/titre	$*	Page
4. Coatings / Revêtements			
King,H.W. Eng. Physics Tech. Univ. N.S.	Plasma sprayed ceramic coatings for use in coal combustion systems * with W.F. Caley (TUNS)	132,100	82
5. Cellulosics / Cellulosiques			
Gray,D.G. Chemistry McGill	Cellulose-based chiroptical filters	65,000	79
6. Other Matrerials / Autres matériaux			
Drake,J.E. Chemistry Windsor	Sulphur-containing compounds as potential additives for lubricants	103,440	75
Ward,M.A. Research Services Calgary	Increasing the fly ash in construction * with R.L. Day, R.C. Joshi, B.W. Langan (Calgary)	445,320	88
7. Metals and Metallurgical Process / Métaux et procédés métallurigiques			
Finch,J.A. Mining/Metal. Eng. McGill	Mineral processing of fine particles * with A.R. Laplante, N. Rowlands (McGill)	150,000	76
Graham,W.A.G. Chemistry Alberta	Carbon-hydrogen bond activation by transition metals	105,000	78
Inculet,I.I. Electrical Eng. Western Ontario	Electrostatic benefication of gold ores and tailings * with G.S.P. Castle, R.M. Quigley (UWO)	76,500	81
McLean,A. Metal/Mat. Science Toronto	Advanced steelmaking processes * with C.B. Alcock, I.D. Sommerville (Toronto)	580,000	84

* Total funds awarded/Montant total accordé

Name/Nom Department/Département University/Université	Title/titre	$*	Page
8. Catalysts and Catalytic Processes / Catalyseurs et procédés catalytiques			
Alper,H.F. Chemistry Ottawa	Novel catalytic processes for synthetic fuels and chemicals * with B.A. Morrow, J.L. Roustan (Ottawa)	129,000	67
Chornet,E. Génie chimique Sherbrooke	Hydroraffinage catalytique des fractions issues de la liquéfaction de la biomasse et de la tourbe: Nouvelles approches basées sur des réacteurs à jet et catalyseurs homogènes et en suspension colloidale	168,800	72
DeLasa,H.I. Chemical Eng. Western Ontario	Pseudoadiabatic reactor configuration for methanol conversion	155,889	73
Hudgins,R.R. Chemical Eng. Waterloo	Improved alcohol synthesis through periodic operation	59,848	80
9. Pulp and Paper Processes / Procédés de transformation des pâtes et papiers			
Avedesian,M.M. Chemical Eng. McGill	Fluidized bed recovery of Kraft black liquor * with A.S. Mujumdar (McGill)	123,000	68
10. Novel processes / Nouveaux procédés			
Childs,R.F. Chemistry McMaster	Charge mosaic piezodialysis membranes * with J.M. Dickson, B.E. McCarry (McMaster)	172,500	71
DeLasa,H.I. Chemical Eng. Western Ontario	Technology for three phase fluidized bed reactors. Novel instrumentation techniques	15,000	74
11. Integrated Systems, CAD/CAM, robotics / Systèmes intégrés, CAO/FAO, robots			
Baldur,R. Génie mécanique Ecole Polytechnique	Compressed air transducers and actuators for robotics * avec A. Bazergui (Ecole Poly.)	150,000	69

* Total funds awarded/Montant total accordé

SUMMARIES OF COMPLETED RESEARCH PROJECTS / TRAVAUX DE RECHERCHE TERMINÉS

Name/Nom: Howard Alper
Department/Département: Chemistry
University/Université: Ottawa
Phone number(Optional)/N° de téléphone (facultatif):
Title of Project/Titre du projet: Novel Catalytic Processes for Synthetic Fuels and Chemicals

Reactions involving synthesis gas [i.e. carbon monoxide and hydrogen] are of considerable industrial importance. Examples include the hydroformylation of olefins [oxo reaction] and the Fischer-Tropsch process. Research carried out over the past ten years have demonstrated the value of phase transfer catalysis for effecting metal catalyzed reactions. Phase transfer catalyzed reactions are generally effected using an aqueous-organic two-phase system with an ammonium salt, crown ether, or polyethylene glycol as the phase transfer agent. This strategic grant has resulted in the discovery of simple and remarkably mild methods for the hydroformylation of olefins under basic or acidic phase transfer catalysis. The dual catalyst system, triiron dodecacarbonyl and hexarhodium hexadecacarbonyl, is active for the basic phase transfer process while cobalt carbonyl complexes are useful under acidic conditions. Either set of conditions result in the formation of the straight-chain (i.e. linear) alcohol or aldehyde as the major or only product. Biphasic or phase transfer catalysis enables one to effect the conversion of synthesis gas to hydrocarbons at 5-22 atmospheres and 70-100°C, using chloro (1,5-hexadiene) rhodium (I) dimer, triiron dodecacarbonyl, and several other metal complexes as catalysts.

The cyanotricarbonylnickelate anion, readily generated from inexpensive nickel cyanide under basic phase transfer catalysis, is a good catalyst for the water gas shift reaction (production of carbon dioxide and hydrogen from carbon monoxide and water). A newly synthesized nitrosyliron complex, $Fe(CO)_2(NO)(PPh_3)_2^+BF_4^-$, was inert for both the water gas shift and hydroformylation reactions.

There has been much worldwide interest in C_1 chemistry, and in the use of methyl formate as a C_1 intermediate. It has been found that rhodium carbonyl is an attractive method for the conversion of methyl formate to carbon monoxide and methanol. This process, in the presence of ethylene, is an excellent way to prepare the bulk chemical, methyl propionate.

Several new classes of iron nitrosyls were prepared (in addition to $Fe(CO)_2(NO)(PPh_3)_2^+BF_4^-$) but were not active for synthesis gas chemistry. This is due to the fact that the thermolabile hydride, generated under the reaction conditions, decomposes to a non-hydridic species. Both iron and cobalt nitrosyls have been deposited on alumina and zeolite Y, and it has been shown that surface isocyanate is generated in such cases. Applications to Fischer-Tropsch synthesis are currently under study.

Publications resulting from this research include the following:

1. V. Galamb, S.C. Shim, F. Sibtain and H. Alper, Carbonium Ion and Hydridocobalt Intermediates in the Acidic Phase Transfer Catalyzed Reaction of Olefins and Dienes with Cobalt Carbonyl, Isr. J. Chem. 1985, 26, 216.

2. F. Joo and H. Alper, Cyanonickel(II) Complexes as Catalysts for the Phase Transfer Catalyzed Carbonylation of Allyl Halides. The Isolation of the Catalytically Active Species, $[Ni(CO)_3)CN]^-$, Organometallics, 1985, 4, 1778.

3. F.R. Ahmed, J.L.A. Roustan and M.Y. Al-Janabi, Structure of Bis(triphenylphosphine) nitrosyliron Tetrafluoroborate-Dichloromethane and Correlation of the Fe-P Bond Length with the Degeneracy Weighted Stretching Frequency of Carbon Monoxide, Inorg. Chem., 1985, 24, 2526.

4. H. Alper, Decarbonylation of Formate Esters, patent filed Feb. 24, 1986.

Name/Nom: M.M. Avedesian
Department/Département:
University/Université:
Phone number(Optional)/N° de téléphone (facultatif):
Title of Project/Titre du projet:

2.0 SUMMARIES OF COMPLETED RESEARCH PROJECTS

Name: Michael M. Avedesian
Department: Chemical Engineering
University: McGill University
Phone Number: (514) 392-4493

Title of Project: Fluidized Bed Recovery of Kraft Black Liquor

The kraft pulping process is the dominant chemical pulping method in Canada. In this process wood chips are digested in an alkaline solution containing sodium hydroxide and sodium sulfide. The products of this digestion are liberated fibres and a darkish brown by-product aqueous stream called weak black liquor. This consists mostly of solubilized lignin and a significant portion of the degraded chemical components.

For the kraft process to be economical it is essential to make use of the lignin by-product and to restore the composition of the chemicals for recycle to the digestors. This has been done for over 50 years using the conventional Tomlinson boiler. At the present time the state-of-the-art recovery units may cost upwards of 150 million dollars and frequently there are explosions which cause loss of life and equipment. It is therefore becoming imperative for Canadian produces of kraft pulp to develop safer and less expensive alternatives in order to maintain the competitive edge in a tight global market.

The investigation conducted by researchers at McGill University has centered on developing fundamental knowledge of a pilot-scale fluidized bed reactor. The purpose has been to investigate the potential of this system in replacing the Tomlinson recovery boiler. As an integral part of this work, extensive pilot scale facilities and analytical equipment have been set up on the McGill campus. The experimental unit is capable of processing 1 kg/hr of kraft black liquor solids in a safe and reliable fashion.

References

1. Paper presented at the DOE Energy Review Meeting of Recovery Technology, Institute of Paper Chemistry, Appleton, Wisc., Oct. 1-3, 1986. Info available from DOE by contacting Stanley Sobjyinski.
2. "Oxidation of Sodium Thiosulfate in Weak Kraft Black Liquor". S.K. Sen Gupta. M.Eng. Thesis, McGill University, Jan. 87.
3. "Kraft Black Liquor Recovery in a Fluidized Bed: Part I - A Review", J. Fallavollita, M.M. Avedesian, A.S. Mujumdar, accepted for publication in Can. Journal of Chem. Eng., 1987.
4. "Operation Characteristics of a Fluidized Bed Reactor for the Treatment of Kraft Black Liquor Powder", accepted for publication in the Proceedings of the 37th Canadian Chemical Engineering Conference, Montreal, May 18-22, 1987.

Name/Nom: Roman Baldur and André Bazergui
Department/Département: Mechanical Engineering
University/Université: Ecole Polytechnique de Montréal
Phone number(Optional)/N° de téléphone (facultatif): (514) 340-4861
Title of Project/Titre du projet: "Compressed Air Transducers and Actuators for Robotics"

Research was carried out on four district devices as follows:
Force Sensing Grippers. The gripping elements are small inflated bubbles attached to the fingers of the gripper. The deformation of the bubbles due to contact forces changes their internal pressure and this information is used to control the gripping force. The bubbles are flexible and deform themselves to take the shape of the object being manipulated. Possible applications are for robotic grippers for the manipulation of delicate or flexible objects (soft fruit, textiles, rubber and plastics, etc.).
Computer Controlled Pneumatic Robot. A three degree of freedom, 6 ft (2 m) reach robot has been counstructed. It has light members moved by means of air cylinders. The motion of the robot is controlled by a micro-computer and positioning of the movable elements is ensured by pneumatically actuated mechanical brakes. The research resulted in a very light robot of inexpensive construction and a large reach. Further work on vibration damping is still needed.
Inflatable Manipulator. This manipulator consists of a central cylinder, 6" (150 mm) diameter and 6' (2 m) long, which is inflated by a low pressure source. There are 21 "muscles" distributed around the central cylinder and these can be activated by compressed air in any arbitrary pattern. The action of the muscles deform the central cylinder into snake-like shapes. The complete assembly weighs about 10 lbs (5 kg) and is able to support a weight of several pounds at its free end. Shape of the manipulator is micro-computer controlled. Possible applications would be for inspection of inaccessible places by mounting a camera at the tip. Painting could also be performed.
Automatic Guided Vehicle. The main feature of the vehicle is the independence from external devices for the determination of its position. A special transducer, mounted on the vehicle, provides means for dead-reconning navigation by trailing a pivotable wheel. Calculation of instantaneous position and control of the electric motors is achieved by means of a micro-computer mounted on board.

REFERENCES

1. BALDUR, R., BARON L. and BAZERGUI, A., "A Pneumatic Tactile Sensor", SME Robots 10 Proceedings, pp. 3.65 - 3.74, April 1986.
2. BALDUR, R., "Hydraulic Control of Pneumatic Actuators", 2nd Canadian CAD/CAM and Robotics Conference Proceedings, p. 8.11, Toronto, June 1983.
3. BALDUR, R. & HORTH, R., "Microcomputer Programmable Pneumatic Manipulator" Robots 9 Proceedings, pp. 20.58 - 20.66, Detroit, June 1985.
4. BALDUR, R. & BLACH, W., "Inflatable Manipulator" ROBOTS 9 Conference Proceedings, pp. 12.24 - 12.36, Detroit, June 1985.
5. BALDUR, R., LAFERRIERE, M., "Trajectory Optimization of a Guided Vehicle", 7th EAM Symposium, Toronto, June 1984.
6. BALDUR, R., PORTUGAISE, B., "Design of an Experimental Automatically Guided Vehicle", 3rd Canadian CAD/CAM & Robotics Conference, Toronto, June 1984.
7. BALDUR, R., LAGUE, G., "An Inexpensive Robot for Mechanical Engineering Students", Robots 8 Conference Proceedings, pp. 18.68 - 18.77, Detroit, June 1984.
8. BALDUR, R. & Fillion, Y., "Rapid Algorithm for Manipulator Motion Control" ASME International Computers in Engineering Conference, pp. 79 - 86, Boston, August 1985.
9. BALDUR R. and DUBE M., "Interference Between Generalized Solid Links", ASME Computers in Engineering Conference Proceedings, pp. 79 - 86, July 1986.
10. BARON, L., "Un capteur tactile pneumatique", M.Sc.A., 1985.
11. HORTH, R., "Manipulateur pneumatique programmable", M.Sc.A., 1985.
12. DUBE, M., "Interférence entre des membrures solides généralisées", M.Sc.A., 1985.

Name/Nom: Dr. Pierre-André Bélanger — Dr. Pierre Bernard — Dr. Russell Boulay
Department/Département: Physique - LROL — Département de Physique — Institut National
University/Université: Laval — Université d'Ottawa — d'Optique, Québec
Phone number(Optional)/N° de téléphone (facultatif):
Title of Project/Titre du projet: "Application du laser sous-millimétrique dans l'industrie des matériaux en feuilles"

APPLICATIONS OF THE SUBMILLIMETRIC LASER TO THE SHEET MATERIAL INDUSTRY

This strategic research grant (1984-1985) has permitted us to completely develop a method of measurement of the water and fibre content of sheet materials such as papers and boxes, based on the submillimetre laser. We have also experimentally demonstrated that this technology can serve to determine, in a non-destructive manner, the quantity or distribution of certain reinforcement agents in the polymetric matrix (for example: mica in polythylene or polyurathane, glass fibres in an epoxy matrix). Another important accomplishment we have made is the demonstration of the use of polarized submillimeter waves to measure the scale of orientation of the fibres in the paper. These preliminary trials show that the same technique could be extend to the characterization of the filler in composite materials.

APPLICATIONS DU LASER SOUSMILLIMETRIQUE DANS L'INDUSTRIE DES MATERIAUX EN FEUILLES

Cette subvention thématique (1984-1986) nous a permis de développer complètement une technique de mesure, basée sur l'utilisation d'un laser sousmillimétrique, pour mesurer le contenu en eau et en fibres de matériaux en feuilles tels les papiers et cartons. Nous avons aussi démontré expérimentalement que cette technologie pouvait servir à déterminer de façon non destructive la quantité ou la distribution de certains agents de renforcement dans des matrices de polymères (exemples: le mica dans le polyéthylène ou le polyuréthane, les fibres de verre dans une matrice d'epoxy). Un autre accomplissement important est la démonstration que nous avons faite que des ondes sousmillimétriques polarisées pouvaient être utilisées pour mesurer, de façon non destructive, le taux d'orientation des fibres dans le papier. Des essais préliminaires montrent que la même technique pourrait servir à la caractérisation d'agents de renforcement dans les matériaux composites.

Publications

1. BOULAY, R., DUBE, P., BELANGER, P.A., VU-KHANH, T. and CIELO, P.G., "Far-Infrared Inspection Technique in Sheet Industrial Products". SPIE's 1986 Québec International Symposium on Optical Techniques for Industrial Inspection, Québec, vol. no. 665, pp. 352-360 (1986).
2. BOULAY, R. DROUIN, B., GAGNON, R., BELANGER, P.A. and BERNARD, P., "Optical Polirizing Effect of Paper at Submillimeter Wavelengths". SPIE's 1986 Québec International Symposium on Far-Infrared Science and Technology, Québec, vol. no. 666, pp. 200-206 (1986).
3. BERNARD, P., BELANGER, P.A., BOULAY, R., DROUIN, B. and GAGNON, R., "FIR Dielectric Coefficient of Water Close to a Hydrophillic Surface". SPIE's 1986 Québec International Symposium on Far-Infrared Science and Technology, Québec, vol. no. 666, pp. 206-213 (1986).
4. BOULAY, R., DROUIN, B. and GAGNON, R., "Measurement of Local Fibre Orientation Variations". Journal of Pulp and paper science, vol. 12, no. 6, no. 6, J177-J181, Nov. 1986.
5. DOBROWOLSKI, J.A., HO, F.C., BABY, L., BOULAY, R., DROUIN, B., GAGNON, R., and BELANGER, P.A., "Use of the Inverse Synthesis Method for the Determination of the Optical Constants of Paper in the Far Infrared", Applied Optics, vol. 25, no. 16, 2681-2687, August (1986).
6. BOULAY, R., DROUIN, B. and GAGNON, R., "Measurement of Local Fibre Orientation Variations", Journal of Pulp and Paper Science, vol. 12, no. 1, J26-J29, Jan. (1986).
7. BOULAY, R., DROUIN, B. and GAGNON, R., "Measurement of Local Fibre Orientation Variations". 72e Congrès annuel, Section Technique, de l'Association Canadienne des producteurs de Pâtes et Papiers (C.P.P.A.), Montréal, prétirés pp. A111-A115, Janv. (1986).
8. BOULAY, R., DROUIN, B., GAGNON, R., BELANGER, P.A. et CIELO, P., "Far Infrared Moisture Monitoring in Polymeric Composites". POLYMER Communications, Vol. 26, pp. 69-71 March (1985).
9. BOULAY, R., DROUIN, B., GAGNON, R. and BERNARD, P., "Polirizing Properties of Paper at Submillimetre Wavelengths", 71e Congrès annuel, Section technique, de l'Association Canadienne des producteurs de Pâtes et Papiers (C.P.P.A.), Montréal, prétirés pp. A147-A150, Janv. (1985).
10. BELANGER, P.A., O'NEILL, C. and R. BOULAY, "Fiber orientation and optical polarization of paper at submillimeter wavelengths". Article soumis au Journal of Pulp and Paper Science.

Brevets

1. BOULAY, R., DROUIN, B. and GAGNON, R., "Method for Measuring the Fibre Orientation Anisotropy in a Fibrous Structure". Nov. 1986.

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Department/Département: Chemistry & Chemical Engineering
University/Université: McMaster University
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Title of Project/Titre du projet: Charge Mosaic Piezodialysis Membranes

The objective of this project was to produce a charge mosaic membrane which would be suitable for piezodialysis. Such a membrane, which contains discrete cationic and anionic sites placed in separate small domains across the surface of the membrane, would have many potential uses in desalination and the concentration of ionic materials. It was proposed to use a novel micro photo-lithographic approach for the preparation of the charge mosaic membrane.

The key feature of this proposal was to develop a thin film composite membrane which contained a photo-reactive group in the surface layer. The properties of this photoactive group were to be such that, depending on the conditions used, it could be converted on irradiation with long wavelength light to either cationic or anionic exchange sites.

In working on this project, we have been able to prepare thin film composite membranes which contain a photoreactive group. These membranes have been tested for their use in reverse osmosis (RO) by measuring their flux and salt separations with a variety of inorganic salts. The membranes show excellent salt rejection (in excess of 96%) and moderately high fluxes that make them attractive candidates for development into commercial RO membranes.

In a second phase of the work we were able to convert these photoreactive membranes into a large variety of chemically derivatised membranes by irradiating them with light of wavelength greater than 310 nm. It proved possible to readily prepare both cationic and anionic, ion exchange thin film composite membranes by this route. These transformations could be accomplished without modification of the base membrane and the resulting ion exchange membranes exhibited good separation properties. In addition to the production of ion exchange membranes the photo-reactive membranes have proved to be a very convenient way of producing a variety of differently functionalized thin film composite membranes. This has opened the door both to the possibility of the custom design of membranes for specific separations and some systematic work on the effect of surface chemistry on the separation properties of a membrane.

As the project concluded, at the end of three years, we were starting to prepare charge mosaic membranes. The initial experiments look very promising and it would seem that the system we have developed can be used for this purpose. Work is continuing on all of the membranes which have been produced in this project.

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Title of Project/Titre du projet: "Hydro-raffinage catalytique des fractions issues de la liquéfaction de la biomasse: nouvelles approches basées sur des réacteurs-à-jet et catalyseurs homogènes et en suspension colloïdale".

L'objectif de ce projet est l'hydro-traitement de la fraction lignine issue de la liquéfaction de la biomasse en utilisant une technologie nouvelle. Les réacteurs-à-jet dont le but est l'optimisation du transfert de chaleur et de matières.

Afin d'accomplir l'objectif du projet, celui-ci fut divisé en quatre tâches: la mise au point de la technologie, les études catalytiques de base, la production des lignines par voie solvolytique, la caractérisation analytique.

La technologie des réacteurs-à-jet a donné lieu au dépôt d'un brevet. Rappelons que cette technologie est basée sur des forces de cisaillement très élevées qui facilitent un mixage très complet des différents réactifs et catalyseurs. En même temps le chauffage de ces mêmes réactifs peut être fait de façon quasi-instantanée par la chaleur latente de vapeurs organiques injectées dans la chambre réactionnelle.

La production de lignine dite native a donné lieu au développement de l'approche solvolytique fractionnée. Par un choix approprié de solvants nous avons obtenu des lignines avec un rendement de production compris entre 70-80% de la lignine initialement présente dans la biomasse. Rappelons que lors de cette opération les hémicelluloses et la cellulose sont aussi récupérées.

Les études catalytiques de base ont porté dans une première étape sur la rupture des liens C-O-CH_3. L'anisol et le guaicol ont été choisis comme composants modèles. Par traitement thermocatalytique nous avons réussi à pouvoir varier la distribution des produits: benzène, toluène, phénol, crésols et catéchols selon le couplage catalyseur et sévérité du traitement.

Les études d'hydrotraitement de la lignine ont montré que la conversion de la lignine par rupture de lieu C-O-C et C-C est possible. Le résultat est un ensemble de monomères et oligomères dont l'identification est encore en cours d'être effectuée.

Les méthodes analytiques développées au cours de cette étude incluent des séparations par chromatographie (SESC, SEC et GC capillaire) et des analyses calorimétriques (DSC). L'application de l'ensemble de ces techniques facilite la compréhension de la dépolymérisation des macromolécules naturelles.

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Title of Project/Titre du projet: Pseudoadiabatic Reactor Configuration of Methanol Conversion

This project considered the study and the development of a novel fixed bed reactor for exothermic catalytic reactions. It was strongly believed and now experimentally proved that a multitubular packed bed for exothermic reactions can be operated, with heat exchange to a cooling medium, in a regime where the maximum level is reached at the reactor outlet (Pseudoadiabatic Operation).

The specific objectives of the present Strategic Grant project were to experimentally investigate the Pseudoadiabatic regime building a pilot plant unit, to apply this novel reactor concept to the catalytic conversion of methanol into gasoline and to further establish the design criteria of the Pseudoadiabatic Catalytic Reactor for large methanol conversion units.

The result of this investigation has been the development of a Canadian Technology for the economic production of gasoline (methanol can be easily produced from either coal or natural gas) as well as the implementation of a new and promising reactor concept for the design and operation of exothermic fixed bed catalytic reactors.

The significance of this achievement can be fully realized taking into consideration that fixed bed reactors are the most common type of reactors in the chemical industry, followed by trickle beds and fluid-bed reactors.

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Title of Project/Titre du projet: Technology for Three Phase Fluidized Bed Reactors. Novel Instrumentation Techniques

The present program had a primary objective of developing a novel U-shaped fiber optic probe simulating its performance in a hot fluidized bed. The U-shaped fiber optic probe was tested extensively in a hot liquid product (200°C) from a coal-heavy oil coprocessing pilot plant unit. The liquid samples were supplied by Dr. L.K. Lee, Coal Research Department, Alberta Research Council. Gas bubbles in these samples were detected successfully using a system of fiber optic probe-data acquisition-computer in operation at the Chemical Reaction Laboratory, Faculty of Engineering Science, University of Western Ontario. The intensity of the recorded signals were in the range of 0.05-0.4 Volts. These signals were as strong as the ones observed in our previous studies in the air-water-glass beads system.

At the same time and with the objective of tracking swarm of small bubbles, numerical techniques using cross-correlation analysis were implemented.

Collaboration with the Alberta Research Council was started during the present NSERC program. Future activities are also planned to continue this collaboration in the context of completing the development of this promising bubble measuring probe.

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Title of Project/Titre du projet: Sulphur Containing Compounds as Potential Additives for Lubricants

Our main objective was to prepare and characterize organosilicon and organogermanium derivatives of dialkyldithiocarbamates and dialkyldithiocarbamates. If this was successful, we planned to do some preliminary testing of their potential as lubricant additives.

It became clear, at an early stage of this work, that the organosilicon derivatives were so readily hydrolyzed and/or oxidized that to obtain isolatable, thermally stable derivatives we would have to concentrate on the organogermanium derivatives.

A variety of these were prepared by the following general reactions in anhydrous carbon disulphide:

$$R_3GeX + NaS_2CNMe_2 \longrightarrow R_3GeSC(S)NMe_2 + NaX \quad [1]$$

$$R_2GeCl_2 + NaS_2CNMe_2 \longrightarrow R_2Ge[SC(S)NMe_2]Cl + NaCl \quad [2]$$

$$R_2GeCl_2 + 2NaS_2CNMe_2 \longrightarrow R_2Ge[SC(S)NMe_2]_2 + 2NaCl \quad [3]$$

$$RGeCl_3 + NaS_2CNMe_2 \longrightarrow RGe[SC(S)NMe_2]Cl_2 + NaCl \quad [4]$$
(R = Ph, Me) (X = Cl, Br)

$$R_2Ge[SC(S)]NMe_2Cl + Me_3SiX \longrightarrow Me_2Ge[SC(S)NMe_2]X + Me_3SiCl \quad [5]$$
(X = Br, I)

$$R_{4-n}GeCl_n + nNH_4S_2P(OR')_2 \longrightarrow R_{4-n}Ge[S_2P(OR')_2]_n + nNH_4Cl \quad [6]$$
(n = 1,3; R' = Me, Et)

All of the compounds were initially characterized by the presence of the parent ions in the mass spectra, as well as their infrared, Raman and NMR spectra. Their composition was confirmed by elemental analysis and, where possible, solid state structures were confirmed by X-ray structure analysis.

Thus, for example, the X-ray structures confirm that the dithiocarbamate groups are always anisobidentate (i.e. have one strong Ge-S and one weak Ge---S bond, while the dithiophosphate groups are always monodentate with just one strong Ge-S bond. The second S atom is oriented to be well away from germanium and is the outermost atom in the derivative.

All of the dithiophosphates showed no signs of decomposition when small quantities were heated in neutral base oil to 100°C. This was also true of $Me_3Ge(S_2CNMe_2)$ and $Me_2Ge(S_2CNMe_2)Cl$, while the other dithiocarbamates underwent considerable decomposition with liberation of CS_2.

Cost-factors determined that we could only prepare the compounds in relatively small amounts so they have only been subjected to the Normal Four-Ball Wear Test (ASTM D2266). However, these have given promising results. For example, when $Ph_3GeS_2P(OEt_2)$ was dissolved in 150 ml of neutral base oil (30 Kg. load, 90°C, 400 rpm and 45 min) and subjected to the test with steel balls, it showed significant anti-wear characteristics (0.43 mm compared to 0.38 mm for the addition of 5% ZnDDP). Even more encouraging was the strong synergism observed when mixed with ZnDDP (0.31 mm).

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Title of Project/Titre du projet: Mineral Processing of Fines

SUMMARY OF MAJOR ACHIEVEMENTS OF PROJECT

General achievements include: development of team, (3 profs., 3 R.A., 10 G.S.); professional development seminars, at McGill (8) and at plants (3); co-operative work with elevan companies; publication of over 20 articles; creation of test facilities for columns, electrochemistry, fine gravity separation, rod/ball mill grindability, mineral identification (XRD, STEM-EDAX).

Specific technical achievements include:

1. Column flotation: Major industrial impact. Contributions include: scale-up; model of particle collection by bubbles; identified limited benefits from fine (< .5mm) bubbles; model of froth and wash water action; related cleaning to gas rate and froth depth; designed portable column for site testing.
2. Flotation chemistry: Designed reagent combinations to overcome coagulation and bubble coalescence in slime Nb flotation; identified Nb selective collectors suitable for plant water; described process for selective Pb/Zn flotation without Cu activation; preliminary demonstration of pyrite flotation control by N_2/air combinations.
3. Magnetic separation: Demonstrated aqueous oxidation technique to enhance pyrite susceptibility for coal desulphurization; a-c and vibration hgms shown to improve magnetics product grade; employed mag. sep. to concentrate phases to aid identification.
4. Comminution: Grinding circuit simulator constructed to evaluate circuit changes at Brunswick Mining (BM), major findings: ball mill models can be greatly simplified; series ball mills experienced reduced grinding rate compared with parallel mills. Effect of feed variables at BM quantified; Data base of 70 grinding circuits completed, regressions performed and strategy for improved rod milling developed, now being implemented at Les Mines Selbaie and Kidd Creek Mines (KCM).
5. Applied Mineralogy: Techniques developed to identify phases in Zn plant residues (KCM), for example: Cu always found in the most magnetic ferrites; variable Zn/Fe ratio Zn-ferrites suspected. Mineralogical quantification resolved recovery mechanism of Mg in Zn concentrate (Pine Point) as simple locking, complex locking, and entrainment. Locking factor developed to transform section area data to volumetric data.

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Title of Project/Titre du projet: Electrochemical Preparation of Electrically Conducting Polymers

Electrochemical Preparation of Electrically Conducting Polymers

Electrically conducting polymers were formed by the electrochemical polymerization of aromatic heterocyclic compounds auch as pyrrole and thiophene. The polymers exhibit good electrical conductivity (>100 S), and can be switched between conducting (oxidized) and non-conducting (reduced) states whose conductivity differs by 10^{8}. These changes are accompanied by color changes (red to green) and by changes in morphology and in physical properties. Suggested applications for these conducting polymers include electrochromic displays, electrochromic displays, memory elements, ion gate membranes, pH and chemical sensors and circuit elements for macromolecular electronics.

For such applications it is important to provide materials spanning a range of properties such as redox potential. In this work this was accomplished by formation of copolymers of the parent compounds. The copolymer composition can be varied by change in the monomer feed ratio and by change in the electrode potential. The polymer compositions are described empirically by the copolymer equation used in conventional free radical polymerization. The reactivity ratios were determined by analysis of the copolymer composition at several feed ratios.

In general, the physical properties of the copolymers were intermediate to those of the parent compounds. However, the conductivities were enhanced and were higher than those of either homopolymer.

The mechanism of the homopolymerization was probed by dynamic electrochemical pulse techniques, by equilibrium rotating ring disk electrode methods and by macro electrolysis and chemical analysis. Chain growth requires successive oxidation to the radical cation, followed by radical coupling, proton expulsion and reoxidation.

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Title of Project/Titre du projet: Carbon-Hydrogen Activation by Transition Metals

The carbon-hydrogen bonds in hydrocarbons (as in petroleum or natural gas) are highly unreactive, and to convert them to useful petrochemicals with current technology requires very high temperatures to overcome their lack of reactivity. Since 1980, a few hydrocarbon-soluble metal compounds have been found capable of reacting at room temperature and below with carbon-hydrogen bonds, forming new and much more reactive metal-containing compounds. The originally inert carbon-hydrogen bonds are then said to have been activated. Analogy with known reactions suggests that the hydrocarbon portion of the metal-containing compound will undergo further reactions while attached to the metal, ultimately being released in a new, functionalized form.

Most of the activations referred to require ultraviolet light, a severe limitation for large scale processes. Under this grant, the first metal compound capable of net carbon-hydrogen activation in a purely thermal process below 100°C was developed. Comparison of this thermally active compound with others found to be inactive has furthered our understanding of the complex factors involved in these reactions.

Carbon-hydrogen activation should be regarded as one step in potential catalytic processes by which hydrocarbon feedstocks can be converted to petrochemicals with superior efficiency.

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Title of Project/Titre du projet: Cellulose-based Chiroptical Filters

Optical filters are familiar to most people. There are several different types. Photographers often use yellow or ultraviolet filters to block light of a given wavelength from reaching the film. Linear polarizers are a more sophisticated type of filter found in quality sunglasses. They transmit light which is "linearly polarized" - light whose electromagnetic vibrations occur in a single plane, rather than in all directions. Linearly polarized light can be considered as being made up of two equal "circularly-polarized" beams, one left-handed and the other right-handed. We have been attempting to make chiroptical filters which reflect one of these circularly polarized components over a narrow wavelength band. The filter thus appears to be the colour corresponding to the wavelength of the reflected band. All other wavelengths, and the other circularly polarized component pass through the filter unchanged. This is the reason that some liquid crystals display beautiful iridescent colours. But the colours of conventional liquid crystals change rapidly with slight changes in temperature, and are too unstable to use as optical filters. In this project, we wanted to exploit our discovery that some cellulose derivatives form cholesteric liquid crystalline phases (1,2) to make chiroptical filters that are efficient and stable reflectors of circularly polarized light. The wavelength of the reflected light depends on factors such as the concentration of the polymer, its molecular weight, and the temperature of the measurement (3,4). By suitable choice of polymer, solvent and sealant narrow band-pass chiroptical filters were made from concentrate liquid crystalline solution sandwiches between glass or quartz plates. Thin layers of specially purified aqueous (hydroxypropyl)cellulose worked well (5). Unexpectedly, it was found that the cholesteric order which this polymer displays in solution could be partially 'frozen in' when thin films of the polymer were cast from solution, and then heated (6). This provided the sought-for route to solid chiroptical filters.

Possible applications of the filters in the laser field include (i) efficient circular polarizers (ii) band-pass and notch filters (iii) and mirrors for circularly polarized lasers (iv) optical isolators to eliminate back reflection in initial laser systems (7). Low cost application as decorated laminates may also be feasible.

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FIELD OF RESEARCH / DOMAINE DE RECHERCHE
(Check one/cocher la case appropriée)

☐ Biotechnology / Biotechnologie
☐ Food-Agriculture / Alimentation-Agriculture
☐ Communications and Computers / Telecommunications et informatique
☐ Industrial Materials and Processes / Matériaux et procédés industriels
☐ Energy / Énergie
☐ Oceans / Océans
☐ Environmental Toxicology / Toxicologie de l'environnement
☐ Open / Ouvert

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Title of Project/Titre du projet: Improved alcohol synthesis through periodic operation

The project was undertaken to consider how a new technology, namely periodic operation (also called forced feed composition cycling: FFCC) could be used to improve the time-honoured steady-state operation, using symmetrical and unsymmetrical square-waves of CO/H_2 concentration between 230 and 270°C and between 1.97 and 2.93 MPa total pressure. No improvement was found over conventional steady-state operation. However, by dosing CO_2 periodically (representing a mean dose of 2% of the feed), up to a 27% increase was discovered in methanol production over steady operation with a promising reduction in the parasitic production of methane (Nappi et al., 1985). Additional laboratory studies suggested that the catalyst maintains a large inventory of carbon-containing species, whose role in methanol synthesis is not yet clear. Preliminary cost estimates on a 80 million gallon/yr methanol synthesis plant using the CO_2-dosing principle suggest that increased revenues of several million dollars per year should result and that the payback time for the new technology should be about 5 years.

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Title of Project: Electrostatic Beneficiation of Gold Ores

The Project was carried out over the period 1984-86 at the Applied Electrostatics Laboratory of the Faculty of Engineering Science, The University of Western Ontario in collaboration with Dr. R.M. Quigley, Director, Geotechnical Research Centre at the same University. Considering the importance of gold as an industrial material and as an element in world economy, the objective of the project was to investigate the feasibility of the dry electrostatic beneficiation processes as an element in the production of gold.

Gold ore samples were obtained from the following mines: Lake Shore, Macassa, Bousquet, Doyon, Owl Creek, Acquarius Deposit, Macklen Township, Dome, Pamour and Kerr-Addison.

The fundamental preliminary investigations involved triboelectrification studies of both synthetic mixtures and actual gold ores. The studies were carried out in the electrostatic tower developed at the University of Western Ontario (ref. 1). The fundamental investigations were followed by the development and application of the alternating voltage curvilinear electric field separator also developed at the University of Western Ontario and fully described in (ref. 2). The apparatus consists essentially of two planar electrodes arranged to produce AC curvilinear fields. The low electrode made out of conductive material is located on a vibratory conveyor. The upper electrode with its inside surface insulated by a plastic sheet is located at an angle of approximately 9° to the lower electrode and maintained at a high voltage alternating potential. The power supply providing the AC potential has means for varying both voltage and frequency. Among the results, the beneficiation curves for two of the ores, the Doyon and the Owl Creek ore show that under the conditions specified in the report one can extract 70% or more of all the gold in the ore by electrostatically extracting only 20% of the mass.

The results were communicated to representatives of some of the gold mines in Northern Ontario some of which supplied the samples.

Complete data of all the work is available in the form of two reports. 1. 1984-85 Report 58 pages. 2. 1985-86 Report 63 pages. A paper was presented Oct. 1986 - IEEE/IAS Annual Meeting, Denver, Colorado, Conf. Record pp. 1444-1448.

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Title of Project/Titre du projet: Plasma sprayed ceramic coatings for use in coal combustion systems.

Boiler tubes in coal-fired electricity generating plants are vulnerable to chemical corrosion due to liquid slags and gaseous combustion products, and to physical erosion by burning coal and fly-ash particles. The consequent down time for boiler repairs can be extremely expensive and considerable effort has thus been devoted to the development of sacrificial coatings which would enable a plant to run for up to three years between planned maintenance shut downs. Protection methods such as overwelding and coating with aluminum powder are relatively effective for this purpose, but are expensive to apply *in situ*. This project was aimed at the development of less expensive ceramic/metal protective coatings using the technique of plasma spraying.

The ceramic Al_2O_3 is known to have good erosion and corrosion resistance, but plasma sprayed coatings tend to crack and delaminate under thermal cycling, because their thermal expansion coefficients are considerably smaller than those of the steels used for boiler tubes. Al_2O_3 coatings thus require underlying coatings of intermediate thermal expansion coefficients. Rare earth/transition metal oxide ceramics such as La_2NiO_4 have thermal expansion coefficients which are a closer match to those of the underlying boiler tube steels, but these materials are less erosion resistant than Al_2O_3. However, a comphrensive study of mixed Al_2O_3/La_2NiO_4 ceramic coatings has shown that the latter phase is not completely stable during passage through the plasma flame. Similar studies of plasma sprayed mixed Al_2O_3/ZrO_2 ceramic coatings have shown that a 50/50 mixture has a thermal expansion coefficient comparable to that of boiler tube steels and exhibits relatively good erosion resistance. Plasma spray coatings of a range of pure metals and ductile alloys have also been investigated. These have superior erosion properties than the ceramics and show no deterioration due to thermal cycling.

When a series of boiler tube sections plasma coated with alumina/zirconia mixed ceramics and with various metallic alloys were exposed in a flame tunnel during a 500 h burn using a high ash coal-water slurry (Carbogel), the pure alumina coating failed because of thermal expansion mismatch, but no significant erosion was observed for any of the other samples. These results demonstrated that a single plasma sprayed mixed ceramic coating can form an effective, renewable, sacrificial erosion resistant coating for boiler tubes and that an equivalent effect could be obtained with ductile metallic plasma sprayed coatings, which at present day prices are about 50% less expensive than the ceramic mixtures.

From a scientific standpoint, these experiments showed that ceramic and metal coatings have the same erosion characteristics as the respective bulk materials and that for both materials the erosion rates increase with particle size of the eroding medium up to the particle size of the platelets of the coating, at which point the rate levels off. The erosion rate was also observed to increase at approximately the third power of the particle impact velocity.

Other research performed under this project included the development of plasma sprayed ceramic electrocatalysts for the oxygen evolution reaction in alkaline solutions and a preliminary evaluation of plasma sprayed ceramic coatings for the hot corrosion protection of naval turbine blades. The electrocatytic work is being continued in cooperation with industrial partners, while further development is in progress on thermal barrier coatings for both metals and plastics.

This project enabled one Ph.D., one M.A.Sc. and four B.Eng. students to obtain extensive training in the use of plasma spray techniques. These students are now practising these skills in various industrial applications.

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Title of Project/Titre du projet: Composites de polymères thermoplastiques et de fibres de bois.

Résumé du projet de recherche

Sommaire des travaux préliminaires effectués dans nos laboratoires sur les composites thermoplastiques.

Des pâtes mécaniques de tremble, d'épinette et de sapin ont servi comme renforceur et/ou remplisseur dans un polymère de polystyrène (1). Les fibres greffées de ces pâtes nous donnent la meilleure amélioration des propriétés mécaniques des composites, les contacts fibre greffée polystyrène étant supérieurs. L'amélioration des propriétés mécaniques des composites de polystyrène avec 30% de fibres greffées (longueur moyenne 0,3 mm) se résume comme suit: Module d'élasticité: +49%; Energie: +67%; Longueur de rupture: +92%. Dans un de nos projets (2), on compare les propriétés mécaniques de composites à base de polyméthacrylate de méthyle avec des agents de remplissage tels que: fibre de verre, mica et fibres greffées (pâte chimicothermomécanique de tremble). On constate une forte amélioration des propriétés des composites avec des fibres greffées comparativement au polymère original (modulus +129%, énergie +750% et la contrainte +325%), et aussi l'amélioration par rapport au mica ou aux fibres de verre préparées sous les mêmes conditions que les composites avec fibres du bois. Dans nos travaux préliminaires avec le polyéthylène (LLDPE de Novacor), on démontre également la supériorité des composites avec une pâte chimicothermomécanique de tremble greffé (3): modulus: +260%; contrainte: +230%; énergie de rupture: +210%, tous par rapport avec LLDPE non-renforcé. En comparant, les composites avec les fibres du bois à celles des fibres du verre ou mica, ils ont aussi une plus grande énergie de rupture: +100%; contrainte: +106% et modulus: +75%. Dernièrement on a aussi démontré, que les fibres greffées du CTMP de tremble sont d'excellents renforceurs pour PVC (R1) (PVC de B.F. Goodrich, renforcé par 30% de fibres de bois augmente la contrainte de 10.25 MPa à 22.7 MPa; l'énergie de 0.03J à 0.068J et le modulus de 368 MPa à 817 MPa). La coopération avec la compagnie Novacor Chemicals dans la recherche et le développement des composites des polyéthylènes et fibres du bois a résulté en deux demandes de brevets (4,5). Notre connaissance a aussi avancé depuis l'an dernier dans le traitement des fibres par polycondensation. Ce traitement avec isocyanates polymériques ayant un coefficient de solubilité très près de celui de la matrice polymérique a conduit aux excellentes propriétés des composites finales. Considérant le coût d'environ 5$/kg des isocyanates polymériques et du pourcentage très bas, nécessaire au traitement des fibres, on prévoit le potentiel de ce traitement pour l'application industrielle. Les procédures et propriétés de ce travail sont déposéesdans les brevets (6,7,8) pour PS et PVC.

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7. B.V. Kokta, "COMPOSITES OF CELLULOSIC FIBERS AND VINYL CHLORIDE POLYMER BONDED BY A SILANE BONDING AGENT", Canadian Pat. Appl.: April 22, 1986; U.S. Application: May 1986.
8. B.V. Kokta, "COMPOSITES OF CELLULOSIC FIBERS AND POLYSTYRENE BONDED BY AN ISOCYANATE BONDING AGENT", Canadian Pat. Application: April 29, 1986; U.S. Application: May 1986.

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Title of Project/Titre du projet: "Advanced Steelmaking Processes:

SUMMARY

The major aim of this research has been to develop new knowledge and expertise which would assist in the implementation of new technology for advanced steelmaking systems.

Specific attention was directed towards the following aspects:

(1) External processing of hot metal and molten steel,
(2) Improved product quality and metal yield during continuous casting,
(3) Development of a physico-chemical sensor for iron and steelmaking.

The scientific approach involved the following techniques:

(a) High temperature chemistry experiments with levitated steel droplets, crucible studies with continuous monitoring of reaction rates for gas/slag and gas/metal reactions, and high temperature microscopy of molten slags.
(b) Continuous casting studies involving fluid flow experiments with water models and a horizontal caster suitable for the production of 25 mm diameter steel billets.
(c) Development of a sensor for evaluation of steel quality and monitoring of steelmaking processes based on the use of ultrasonic devices.

Specifically all of the following original objectives have been attained:

(1) To develop and characterize slags capable of removing sulphur and phosphorus to very low levels from either hot metal or steel.
(2) To evaluate the thermodynamic data for various binary iron alloys with transition elements such as Ni, Co, Cr, Mn and V and to describe these data in expressions suitable for computerized data storage.
(3) To evaluate the effectiveness of different tundish configurations with respect to improvements in metal quality.
(4) To determine the critical chemical and physical factors governing the melting behaviour of mold fluxes.
(5) To investigate horizontal casting as a new technology for the production of high quality steels.
(6) To develop a device which will produce output signals directly related to process variables, which can then be used to evaluate steel quality.

In each of the major project areas, funding was used for the support of senior scientists and engineers working within the steelmaking group at Toronto. Although not supported by strategic funds, the graduate students in the group benifited from association with senior scientists funded by this grant, and also from close interaction with industrial personnel. Part of the socio-economic benefit from this research program has been the provision of well qualified engineers for the Canadian steel industry.

Over thirty papers have been published and several patent applications are being processed by the Innovations Foundation of the University of Toronto.

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Title of Project/Titre du projet: Delayed Failure of Composites

Fibre reinforced composites are replacing traditional engineering materials in many applications where a high strength or stiffness are required along with low weight. Major applications are in aircraft or space structures where weight economies are very important. In many applications, it is not so much weight economy, but rather corrosion resistance that makes fibre composites the materials of choice. Large tanks, pressure vessels and pipes made by filament winding are now in widespread use in the chemical and materials processing industries. Composite materials for structures are usually designed on the basis of static properties, that is strength and stiffness. However, many composites experience time dependent degradation of properties which is determined by the nature of the physical or chemical environment and the occurrence of cyclic loading. Thus, failure in service may occur in time due to a variety of micromechanical processes which include, for example, the slow growth of subcritical cracks, accelerated by the combined action of stress and environment. The program was concerned with the causes of this delayed failure by examining the failure behavour in various liquid environments, and the effect of material parameters on delayed failure.

The investigations are classifiable in three or four categories. In the first study, an experimental facility was designed and built to enable the testing of filament wound glass fibre pipes internally pressurized to as high as 5000 psi and exposed to corrosive environments. This work was supplemented by a second group of studies in which short sections of pipe were tested for hoop strength while exposed to corrosive liquids using a tensile testing machine. This second type of test procedure avoids many of the problems encountered in the pressure tests. During these tests, acoustic emission techniques were successfully developed to detect the onset of failure problems. A third test program was based on the use of flat plate laminated samples to simulate the filament wound pipes. The flat laminates were made by stacking unidirectional layers, or plies, in various angle sequences to simulate the winding angles used in making pipe. These laminates were tested in air, nitric acid, or oxalic acid using various specimen geometries. These tests permit the assessment of the effects of these acids on crack growth rates.

Some preliminary work also was done on characterizing sheet moulding compounds. These are materials containing randomly oriented short fibres in a matrix of resin and filler materials, and are being used in automotive applications.

1. A New Method for Determining Hoop Strength in Filament Wound Pipe Subjected to Corrosive Environments, P.M.Ostaff, E. Teghtsoonian, J.S. Nadeau, submitted to ASTM Journal of Testing and Evaluation, 1987.

2. Delayed Failure of Filament Wound Fiberglass Pipes in Hostile Environments, J.S. Nadeau, E. Teghtsoonian, P. Ostaff and C. Legzdins. In preparation for submission to Composites, 1987.

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Title of Project/Titre du projet: Improved Piezoelectric Ceramics for High Frequency Ultrasonic Transducers.

Improved Piezoelectic Ceramics for High Frequency Ultrasonic Transducers

Patrick S. Nicholson, Professor
Ceramic Engineering Research Group
Department of Materials Science and Engineering
McMaster University

This project concerned the development of piezoelectric ceramics (PEC) for use in high frequency (≤ 100 MHz) ultrasonic transducers suitable to inspect advanced ceramic components for defects ≤ 10 μm in size. Ceramics are highly attenuating which means the transducers must be powerful. This can be achieved by focussing the ultrasound but the efficiency of focussing depends on the transducer diameter. This in turn is determined by the dielectric constant of the PEC in the transducer. This factor together with the velocity of sound in the PEC (which determines its thickness to generate a given frequency) are the major parameters to be considered in PEC's for ≤ 100 MHz ultrasonic transducers. Both thickness and sound velocity should be maximized

The velocity of sound in the lead metaniobate (LMN) and sodium potassium niobate (SPN) PEC's developed is high (~6.8 km/sec). The SPN developed was a 50:50 mixture of the two niobates hot-pressed to theoretical density and very fine grain size (≤ 2 μm). The dielectric constant of the SPN PEC's was 380 and k_t and k_p were equally 45%. Transducers constructed using this SPN had element thicknesses of 56 μm (65 MHz) and 40 μm (85 MHz). These transducers could be excited at three frequencies using a tone-burst excitation system (85, 60 and 30 MHz and 64, 30 and 15 MHz). This facility allows quick detection and detailed analysis of defects without moving the transducer. BaO-doped LMN had a sound velocity of 6.8 km/sec. and dielectric constant of 180. This material was used to construct a 100 MHz element, 28 μm thick and 2 mm diameter. This small diameter made focussing of the ultrasound from the element difficult. Efforts are underway to reduce the dielectric constant of PEC's further so larger diameter elements can be used in these transducers.

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Title of Project/Titre du projet: "Preparation and Characterisation of Novel Conducting Polymers and Related Materials"

The planned preparative routes to conducting C-N-S containing polymers was unsuccessful, but lead instead to: A. A first class chemical synthesis, and full characterisation of, powdered $[SN]_x$ (ref. 1). B. The synthesis and X-ray crystal structure of untwinned single crystals of $[SN]_x$. C. The simple quantitative preparation of a wide variety of salts of $R\overbrace{CSNSN}^{+}$ 1, $R_1\overbrace{CSNSCR_2}^{+}$ 2, $R_2\overbrace{CSNSCR_2}^{+}$ and $R_2\overbrace{CSNSCR_2}^{+}$ ($R_2C\text{-}CR_2$) all potential precursors to C-N-S containing conducting polymers (ref. 2,3). D. The quantitative synthesis, in dilute solutions, of the radicals $R\overbrace{CSNSN}\cdot$ 3 and $R\overbrace{CNSNCR}\cdot$ 4 (ref. 3), and the discovery of a very novel photochemically symmetry allowed rearrangment of 3 to the isomeric $R\overbrace{CNSSN}\cdot$ 5 (refs. 4, 5). E. The discovery of a new class of materials, that are liquids at N.T.P. and consist of completely dissociated monomeric radicals, i.e. 3(R=tBut), 4($R=CF_3$), 5(R=tBut). We can reasonably claim to have discovered a new class of materials - the paramagnetic liquids (refs. 5,6). In addition, all 5 likely are paramagnetic liquids on melting (e.g. 5, $R=CF_3$). 4($R=CF_3$) is thermally stable up to 250°C and the X-ray crystal structure shows it consists of radicals separated by 4Å in the solid state, which is essentially diamagnetic (ref. 6). These compounds are rare examples of main group non-sterically hindered thermally stable radicals with essentially no tendency to dimerise in their standard state. Other examples include O_2, $C\ell O_2$ and $(CF_3)_2NO$.

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STRATEGIC GRANTS / SUBVENTIONS THÉMATIQUES

Summary of Research Project/Résumé du projet de recherche

(Check one/cocher la case appropriée)

- ☐ Biotechnology/Biotechnologie
- ☒ Industrial Materials & Processes
- ☐ Oceans/Océans
- ☐ Open/Ouvert
- ☐ Computers and Communications/ Télécommunications et informatique
- ☐ Environmental Toxicology/ Toxicologie de l'environnement
- ☐ Food/Agriculture/ Alimentation et agriculture

Name of Grantee/Nom du bénéficiaire: M.A. Ward, R.L. Day, B.W. Langan, R.C. Joshi

Department/Département: Civil Engineering

University/Université: The University of Calgary

Phone number (optional)/N° de téléphone (facultatif): 220-5821

Title of Project/Titre du projet:

Increasing the Use of Fly Ash in Construction

Fly ash, a by-product from coal-fired generating stations, possesses cementitious properties which can be used to advantage in a large number of construction situations. The use of fly ash as a partial replacement for cement in concrete construction utilizes an otherwise waste material and reduces cement requirements. As a result the large amount of energy required to manufacture cement is reduced.

The objectives of the program were to increase acceptance of fly ash in many conventional situations in which it is currently either used in small quantities or not at all and to establish new areas where concretes containing fly ash have specific advantages over conventional concretes. These goals were pursued through a number of separate projects utilizing both basic fundamental and practical approaches, studying the basic properties of the materials involved, processes, procedures and applications under service conditions.

The seventeen most significant projects were Characterization of Fly Ash, Fly-Ash Reactivity, Microstructural Examinations, Fractionation of Fly Ash, Permeability of Fly-Ash Concrete, Limestone/Fly Ash Replacement for Cement, Sulphate Resistance of Fly-Ash Mortars, Fly Ash and Alkali-aggregate Reaction, Air Entrainment in Fly-Ash Concrete, Freeze-thaw Resistance of Fly-Ash Concrete, Strength of High Fly-Ash Concretes, Early Strengths of Fly-Ash Concrete, Strength Under Realistic Curing Regimes, Fly-Ash Mortars in Seawater, Use of Fly Ash in Concrete Flatwork, Roller Compacted Concrete and Fly-Ash Bricks. Industry input in the form of an advisory committee was obtained throughout to maintain maximum relevance and direct accessibility to results by engineers, contractors and concrete suppliers.

Some of the results of the work have been transmitted in the form of seventeen published documents. A number of the projects are of an ongoing nature under separate NSERC funding and it is expected that at least eleven additional publications are forthcoming.

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Title of Project/Titre du projet: "Growth and Characterization of Gallium Arsenide and Other Semiconductor Single Crystals"

A facility has been developed to grow semiconductor single crystals by Czochralski crystal pulling from the melt. Crystals up to 7.5 cm diameter and 15 cm in length can be grown of good quality. Germanium crystals have been produced as well as smaller LEC GaAs crystals at 2 atmospheres pressure. Facilities for cutting, polishing and etching semiconductor crystals, including GaAs are also available. An extensive mathematical model of the thermal and stress fields in LEC GaAs growing crystals has been developed as a function of the growth variables. The results indicate directions to be taken to reduce local stress levels and therefore dislocation levels in GaAs. A thermal model of the Bridgman vertical growth of cadmium telluride has also been developed.

A series of investigations have been carried out to characterize GaAs wafers, mostly related to crystals produced by Cominco Ltd.

1) Quantitative measurements of the density and distribution of etch pits on GaAs wafers by Image Analysis has been carried out. The entire surface of the wafer is measured. Wafers at increasing distances from the seed have been compared.
2) Quantitative surface topography measurements of GaAs have been made using a profilometer and analysed by Fast Fourier Transform. The topography is related to optical estimates of the surface roughness used in the industry.
3) Dislocations in as-grown crystal wafers have been observed directly by Transmission Electron Microscopy. Lattice defects and dislocations generated by ion implanting and annealing have been observed on transverse sections of GaAs by T.E.M.
4) Impurities on the surface and in the surface region of GaAs have been observed using Secondary Ion Mass Spectrometry before and after annealing.
5) Dislocations and strain or impurity fields associated with them has been observed in GaAs by cathodoluminescence. The observed dislocations have been shown to correlate well with etch pits.
6) High temperature annealing and straining of GaAs (950 to 1050°C) have shown that the cathodoluminescence image of dislocations changes during annealing. The as-grown dislocations have been shown to move under stress. At higher stresses new dislocations are generated aligned parallel to the bending axis.

SUMMARY

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Title of Project/Titre du projet: **ORDERED POLYMERS BY SOLID PHASE PROCESSING**

Near their crystalline melting temperatures extruded linear polyolefins such as high density polyethylene or isotactic polypropylene may be ultradrawn into clear transparent sheets having greatly increased strength and modulus in the draw direction. The process of ultradrawing is accomplished by tensile drawing of a preheated rectangular billet through the nip of a pair of heated rolls. At a draw ratio of 20 these polypropylene sheets possess predominantly unidirectional orientation with a Young's modulus near 20 GPa and a corresponding tensile strength of 0.5 GPa in the draw direction. Similar values were also found for linear polyethylenes. The viscoelastic behaviour of polypropylene during the roll-drawing process has been modelled and related to the mechanical properties of the resulting drawn sheets. The mechanical properties of the uniaxial drawn sheets may be interpreted from the known mechanics of fibre reinforced composites including the angular dependence of yield stress in relation to the direction of orientation. The ordered polyolefin sheets may be subsequently laminated by adhesive, ultrasonic or electromagnetic induction heating methods to form multiply laminates having controlled biaxial properties. The ultrasonic lamination method may be extended to the use of adhesive tie layers so that ordered polymers may be bonded with dissimilar materials such as other thermoplastics, thermosets, metals, wood, paper or ceramics. In other examples the surfaces of the ordered sheets have been chemically modified by plasma treatment to increase the polarity of the surfaces and make them more receptive to structural adhesives, printing inks, paints or finishes. These biaxial self-reinforced laminates combine a relatively low density with high strength and high modulus so that the specific properties compare favourably with those of many advanced composite materials including aramid and carbon fibre composites, ie. they combine the toughness and strength of Kevlar aramid laminates with the stiffness of carbon fibre composites. Preliminary experiments demonstrate that such ordered laminates may be compression molded or thermoformed by conventional molding techniques.

Ordered polymers are characterized by several unusual properties such as increased melting temperature, susceptibility to annealing, increased thermal conductivity, reduced thermal coefficient of expansion, low surface energy, outstanding fracture toughness at low temperatures, and reduced permeability to gases. The roll-drawing process is applicable to other crystalline thermoplastics that can be drawn into fibres. Research is continuing on the further characterization of these high performance thermoplastic materials for use in domestic and defense applications.

REGULATIONS GOVERNING THE USE OF GRANT FUNDS
(Excerpts from the 1986-87 Awards Guide) /

RÈGLEMENTS RÉGISSANT L'UTILISATION DES SUBVENTIONS
(extraits du Guide des subventions 1986-1987)

Description

86. Strategic grants are offered to individuals and groups to assist with the direct operating costs of research projects (including the organization of workshops and seminars) or with the purchase of equipment essential to the pursuit of research projects in the following areas:

- biotechnology
- communications and computers
- energy
- environmental toxicology
- food and agriculture
- industrial materials and processes
- oceans

In addition, through an "open" area, researchers may submit proposals in fields of national concern other than the seven designated areas.

Although individual applications are considered, group applications with a multifaceted approach are encouraged.

Strategic conference grants assist with the organization of conferences in areas of national concern.

Strategic Equipment Grants

104. Strategic equipment grants must only be used to purchase the equipment for which the grant was awarded. If recipients of strategic equipment grants do not require the full amount awarded for this purpose, they must refund the balance to NSERC. A researcher who is not able to purchase the equipment specified, or who wishes to select alternative equipment, must submit a written request to NSERC outlining the reasons for the change. The modified request will be assessed and the grantee will be informed of Council's decision.

NSERC expects beneficiaries of strategic equipment grants to make operating time available to other interested researchers whenever possible.

General Principles

205. Grant funds must be used effectively, economically, and in the best interest of the research supported by the grant. The financial administration of grants and the conditions governing their use are not intended to restrict grantees, but to ensure good accounting and administrative practices.

The administration of NSERC grants is carried out by three parties: the grantee, the university and NSERC.

- The grantee approves expenditures in accordance with NSERC regulations (outlined in the Awards Guide or imposed as a condition of a grant) and with university policies.
- The university administers the grant funds and establishes appropriate policies, controls and systems to ensure that NSERC policies and regulations are followed.
- NSERC defines the conditions under which grant funds may be used, monitors the use of grant funds, and interprets its rules and regulations for the university and grantees.

Description

86. Les subventions thématiques sont accordées à des chercheurs individuels ou à des groupes pour aider à couvrir les frais directs de leurs projets de recherche (y compris l'organisation de colloques et séminaires) ou à acheter des appareils de recherche nécessaires dans les domaines suivants:

- alimentation et agriculture
- biotechnologie
- énergie
- matériaux et procédés industriels
- océans
- télécommunications et informatique
- toxicologie de l'environnement.

Il existe également un thème «ouvert», dans le cadre duquel les chercheurs peuvent soumettre des propositions dans des domaines d'intérêt national autres que les sept thèmes choisis.

Même si les demandes individuelles sont acceptées, le CRSNG encourage les chercheurs à présenter des demandes de groupe à caractère pluridisciplinaire.

Les subventions thématiques pour conférences soutiennent l'organisation de conférences dans des domaines d'intérêt national.

Subventions thématiques d'appareillage

104. Les subventions thématiques d'appareillage ne doivent être utilisées que pour l'achat de l'appareillage pour lequel la subvention a été accordée. On doit retourner au CRSNG tout montant non utilisé à cette fin. Un chercheur qui ne peut acheter l'appareillage décrit dans la demande ou encore qui désire choisir un autre appareil doit faire une demande écrite au CRSNG, en donnant les raisons du changement. Le CRSNG étudiera la demande et informera le bénéficiaire de sa décision.

Le CRSNG s'attend à ce que les bénéficiaires de subvention thématique d'appareillage mettent du temps de fonctionnement de l'appareil à la disposition d'autres chercheurs intéressés, lorsque cela est possible.

Principes généraux

205. Les subventions doivent être utilisées de façon efficace et économique, de manière à favoriser le plus possible la recherche subventionnée. L'administration financière des subventions et les conditions régissant leur utilisation n'imposent au bénéficiaire qu'un minimum de restrictions, mais exigent de bonnes pratiques comptables et administratives.

Les subventions du CRSNG sont administrées par trois parties: le bénéficiaire, l'université et le CRSNG:

- le bénéficiaire approuve les dépenses en se conformant aux règlements du CRSNG (décrits dans le Guide des subventions ou imposés lors de l'octroi de la subvention) et aux politiques de l'université;
- l'université administre les fonds et établit les politiques, les contrôles et les systèmes nécessaires pour assurer le respect des politiques et règlements du CRSNG;
- le CRSNG définit les conditions régissant l'utilisation des fonds, contrôle l'utilisation des fonds et interprète ses règlements pour l'université et les bénéficiaires.

This chapter describes the financial administration of grant funds and outlines the regulations governing their use. Grantees who wish to use their grant funds to purchase resources or services not covered by explicit NSERC guidelines must consult their research grants officer or business officer, prior to committing any NSERC grant funds to such a purchase. If there is no explicit NSERC guideline to answer a question or no university policy covering the subject, the research grants officer or the business officer will seek an appropriate ruling from NSERC.

Ce chapitre décrit l'administration financière des subventions et les règlements en régissant l'utilisation. Le bénéficiaire qui désire utiliser ses fonds pour acheter des ressources ou des services non prévus dans les directives explicites du CRSNG doit consulter le responsable de la recherche ou du service des finances avant d'engager une part quelconque des fonds du CRSNG pour l'achat envisagé. Si les directives du CRSNG ne peuvent répondre à une question, ou s'il n'existe pas de politique universitaire à ce sujet, le responsable de la recherche ou du service des finances s'en remettra au CRSNG pour obtenir une décision appropriée.

Fiscal Period

212. NSERC grants are awarded to cover expenditures incurred during a specific period of time termed the fiscal period. The fiscal period for operating grants commences on April 1 of the year of the initial award and may be for one, two or three years. The fiscal period for strategic grants commences on November 1 of the year of the initial award and may be for one, two or three years. If not otherwise specified in published program descriptions or in direct correspondence with grantees, the fiscal period for other awards is one year from the date of the award (see paragraph 213). Upon receipt of a written request, NSERC may extend the fiscal time period of the grant if it is considered to be in the best interest of the research.

Période financière

212. Les subventions du CRSNG couvrent les dépenses engagées pendant une période désignée période comptable. La période comptable des subventions pour dépenses courantes débute le 1er avril et peut durer un, deux ou trois ans. La période comptable des subventions thématiques débute le 1er novembre de l'année où la subvention est accordée et peut durer un, deux ou trois ans. À moins d'indication contraire dans la description du programme ou dans les conditions d'octroi, la période comptable des autres subventions dure un an à compter de la date d'octroi (voir l'article 213). Sur réception d'une demande écrite, le CRSNG peut prolonger la période comptable d'une subvention s'il juge que c'est dans le meilleur intérêt de la recherche.

Commitments

215. NSERC receives funds for its programs through annual parliamentary appropriations. Thus, all commitments for support beyond the current fiscal year (e.g., second and third instalments of two- and three-year grants) are made subject to the availability of funds. Under no circumstances is NSERC able to accept responsibility for commitments incurred by grantees that exceed the actual funds to their credit in the NSERC Common Grant Account at the university.

Engagements

215. Le CRSNG reçoit du gouvernement des fonds pour ses programmes de subventions et bourses sous forme de crédits parlementaires annuels. Le CRSNG prend donc des engagements pour les années financières postérieures à l'année courante (p. ex. les deuxième et troisième versements de subventions de deux ou de trois ans) sous réserve de la disponibilité des fonds. Le CRSNG ne peut donc accepter aucune responsabilité à l'égard d'engagements financiers qui dépassent les fonds disponibles dans le compte commun des subventions à l'université.

Indirect or Overhead Costs

219. The funds provided through NSERC grants in aid of university research must not be used to contribute to the payment of indirect or overhead costs of research.

Frais indirects ou généraux

219. Les bénéficiaires ne doivent pas utiliser les fonds octroyés par le CRSNG dans le cadre de ses programmes de subventions pour payer des frais indirects ou généraux de recherche.

Payment of Salaries and Stipends

222. NSERC grantees may use their research grant funds to contribute towards the payment of salaries or stipends of qualified people working in their laboratories on a part-time or full-time basis. However, grant funds must not be used to pay any part of the salary or employee benefit plans of the grantee, members of the grantee's immediate family, other staff members of a Canadian university whose status would make them eligible to apply on their own behalf for NSERC grants, or recipients of other direct NSERC support. Grant funds must not be used to employ secretaries, but may be used to pay for typing services for manuscripts and reports.

Salaires et traitements

222. Les bénéficiaires de subvention du CRSNG peuvent utiliser leur subvention de recherche pour payer les salaires ou traitements de personnes qualifiées travaillant à temps complet ou partiel dans leurs laboratoires. Cependant, ils ne peuvent s'en servir pour payer une partie du salaire ou les avantages sociaux du bénéficiaire, des membres de sa famille immédiate, des membres du personnel d'une université admissibles aux subventions du CRSNG ou encore des bénéficiaires d'autre forme d'aide directe du CRSNG. Ils ne peuvent l'utiliser pour employer une secrétaire, mais peuvent s'en servir pour payer les services de dactylographie pour les manuscrits et les rapports.

Persons in one of the following three categories may be employed under a grant:

— assistants employed to help grantees carry out their research (research associates, research assistants, undergraduate students, programmers, technicians and other technical and non-professional assistants);
— postgraduate students and postdoctoral fellows receiving a stipend to work under the grantee's supervision or as collaborators to the grantee; such persons may not, however, be paid from infrastructure grants;
— visiting scientists receiving transportation, meal and accommodation expenses and stipends (if they are not themselves eligible to apply for NSERC grants) when invited by grantees to collaborate with them.

Summary of Salaries and Stipends from Grants

Assistants	
—subject to university policies	
Graduate students	
—per annum:	$10.560
—per month:	$ 880

Purchase of Equipment and Other Materiel

237. When purchasing equipment and materiel, grantees must follow university procedures related to purchasing. Grantees must explore the possibility of purchasing equipment manufactured in Canada. Refer to paragraph 249 concerning the purchase of powered vehicles.

Ownership of Equipment and Other Materiel

238. All equipment and materiel (including specialized books and publications, small assets such as cameras, small calculators, binoculars, tents, skis, etc.) purchased with NSERC grant funds belong to the university and not to the individual grantee.

When a researcher is moving to another Canadian university and wishes to move equipment or other materiel purchased with NSERC grant funds, Council encourages the university to accede to such a request provided the equipment is not necessary for the research activities of other researchers at that university. Assets so moved will belong to the new university.

Computing Costs

241. Grant funds may be used towards payment of charges for machine time, programming services and other related expenses essential to the conduct of the research for which the grant was awarded.

Les personnes appartenant à l'une ou l'autre des catégories suivantes peuvent être rémunérées à même une subvention:

— adjoints engagés pour aider le bénéficiaire à réaliser son projet (attachés, adjoints de recherche, étudiants de 1er cycle, programmeurs, techniciens et autres adjoints techniques ou non professionnels);
— étudiants de 2e ou 3e cycle et stagiaires postdoctoraux recevant un traitement pour travailler sous la direction du bénéficiaire ou en collaboration avec lui; ces derniers ne peuvent toutefois pas être rémunérés à même une subvention d'infrastructure;
— scientifiques invités recevant des frais de déplacement, de repas et de logement et un traitement (s'ils ne sont pas eux-mêmes admissibles aux subventions du CRSNG) lorsqu'ils sont invités par le bénéficiaire à collaborer avec lui.

Résumé des salaires et traitements payés à même les subventions

Adjoints	
—traitements assujettis aux politiques de l'université	
Étudiants (2e et 3e cycles)	
—par an:	10 560$
—par mois:	880$

Achat d'appareillage et de fournitures

237. L'acquisition d'appareillage et de fournitures doit respecter les politiques d'achat de l'université. Les bénéficiaires doivent étudier la possibilité d'acheter des appareils fabriqués au Canada. Consulter l'article 249 pour les règlements régissant l'achat de véhicules motorisés.

Propriété de l'appareillage et d'autres biens

238. Tout appareillage et autre matériel (y compris, les livres et publications spécialisés, appareils-photo, calculatrices, jumelles, tentes, skis, etc.), achetés grâce à une subvention du CRSNG appartiennent à l'université, et non au bénéficiaire.

Lorsqu'un chercheur déménage dans une autre université au Canada et qu'il désire apporter avec lui les appareils ou autres biens achetés avec l'aide financière du CRSNG, le Conseil encourage l'université à accéder à sa requête si les appareils ne sont pas nécessaires aux travaux d'autres chercheurs de l'université. Les biens ainsi déménagés appartiendront à la nouvelle université.

Frais d'ordinateur

241. Les subventions du CRSNG peuvent servir à payer le temps-machine, les frais de programmation et autres frais connexes lorsque ces dépenses sont essentielles à la poursuite de la recherche pour laquelle la subvention a été accordée.

Patents

243. NSERC grantees are encouraged to seek patent protection for their inventions or developments, particularly in such a way that will benefit Canada. One method of accomplishing this is to consult with and use the services of Canadian Patents and Development Limited (CPDL). Many universities have an agreement with CPDL to achieve this end.

Publications

244. Grant funds may be used to purchase certain specialized publications not normally obtainable through the university library and that are essential to the research supported by Council. These may include special tables, catalogues of functions, published data, specialized journals and like material. Such publications belong to the university.

245. Grant funds may be used towards costs involved in the preparation of manuscripts, whether for articles in research journals or books, and towards the payment of page charges for publication in scientific journals. Grant funds must not, however, be used to pay for printing costs involved in the publication of a book.

246. Grantees are encouraged, whenever possible, to publish the results of their NSERC supported research in Canadian journals, including not only the Canadian Journals of Research published by the National Research Council, but other Canadian scientific and technical publications as well.

Acknowledgement of NSERC Support

247. In any publication arising from research supported by Council grants, acknowledgement of NSERC assistance is expected.

Travel Expenses

248. Grant funds may be used to pay transportation, accommodation and meal expenses incurred during brief trips away from the grantee's university when these are essential to the research funded through the grant. The expenses may be incurred by grantees or by persons working with or for the grantees. Such trips include field trips (e.g., to collect specimens or samples or to use facilities located elsewhere), trips to consult with colleagues and attendance at conferences, meetings, symposia, etc. Transportation to and from the location(s) of sabbatical leave and personal living expenses while at the place(s) of sabbatical leave are not allowable expenses from operating grants. However, field trips and conference travel during the period of sabbatical leave are allowable as specified above.

Research travel associated with leave in excess of three months is not normally considered a brief trip, but under certain circumstances may be supported through NSERC grants:

Brevets

243. Les bénéficiaires de subvention du CRSNG auraient avantage à protéger leurs inventions ou leurs découvertes, particulièrement de façon à en faire bénéficier le Canada. Ils peuvent, à cette fin, consulter la Société canadienne des brevets et d'exploitation Limitée (SCBE) et recourir à ses services. Plusieurs universités ont conclu à cet effet un accord avec cette société.

Publications

244. Les subventions peuvent être utilisées pour l'achat de publications spéciales, comme des tables de données, des catalogues de fonctions mathématiques, des revues spécialisées et autres renseignements du genre qui ne peuvent être obtenus dans les bibliothèques des universités et qui sont nécessaires à la bonne marche des travaux de recherche subventionnés par le Conseil. Ces publications appartiennent à l'université.

245. On peut se servir des subventions pour payer les frais engagés lors de la préparation des manuscrits, qu'il s'agisse d'articles dans des revues scientifiques ou de livres, et pour payer les frais de publication dans des revues scientifiques. On ne peut toutefois se servir de ces fonds pour payer les frais d'impression qu'entraîne la publication d'un livre.

246. On encourage les bénéficiaires de subventions à publier les résultats de leur recherche subventionnée par le CRSNG dans des journaux canadiens, si possible. Il peut s'agir non seulement des journaux canadiens de recherche publiés par le CNRC, mais aussi d'autres publications scientifiques et techniques canadiennes.

Mention de l'aide du CRSNG

247. Le CRSNG s'attend à ce que les bénéficiaires mentionnent l'aide reçue dans toute publication réalisée grâce à une subvention du Conseil.

Frais de déplacement

248. Les subventions du CRSNG peuvent servir à couvrir les frais de transport, de logement et de repas engagés lors de brefs voyages à l'extérieur de l'université, lorsque ces déplacements sont essentiels à la conduite des travaux de recherche subventionnés. Il peut s'agir des dépenses du bénéficiaire ou de ses adjoints. Ces déplacements incluent les voyages vers les lieux d'expérience (cueillette d'échantillons ou utilisation d'installations de recherche) et pour consulter des collègues ou assister à des conférences, congrès, symposiums, etc. Les frais de déplacement (aller retour) du chercheur vers le lieu de son congé sabbatique et ses frais personnels de séjour au cours de ce congé ne sont pas admissibles. Toutefois, les voyages effectués au cours de ce même congé, vers les lieux d'expérience ou pour assister à des conférences sont admissibles, tel qu'il est précisé ci-dessus.

Tout déplacement lié à des activités de recherche et effectué au cours d'un congé de plus de trois mois n'est normalement pas considéré comme un voyage de courte durée; toutefois, il est parfois possible, dans des circonstances spéciales, d'en assurer le financement à l'aide des subventions du CRSNG:

— To spend research leave outside Canada – candidates must apply through the international programs of NSERC.
— To spend research leave within Canada for 3-6 months – operating, strategic and university-industry grant recipients must apply to NSERC for permission to use research grant funds for transportation expenses only.
— To pursue an extended field trip or to visit a foreign facility in excess of 3 months – permission must be granted by NSERC in writing.

Claims for travel expenses chargeable against NSERC grants must conform to the standard procedures and policies of each grantee's university, and a university has the right not to authorize an expenditure proposed by the grantee if such an expenditure contravenes university policies and or any NSERC regulations. See paragraph 211 for submission of travel claims.

Grant funds must not be used to reimburse any travel expenditures for members of the grantee's immediate family.

Powered Vehicles

249. Recipients of NSERC grants may purchase a powered vehicle when essential to the research funded through the grant. However, prior university approval is required. By approving the purchase, the university accepts responsibility to provide insurance and any licence required and to register the vehicle in the name of the university. Grantees may also use their grant funds to pay for the long-term lease or short-term rental of such vehicles essential to the research funded through the grant. Grantees who wish to lease a powered vehicle on a long-term basis require the prior authority of the university. This procedure is similar to that required for an outright purchase.

Costs of short-term rentals of vehicles will be recorded on travel claims with other expenses of the field trips, etc.

If powered vehicles purchased through the grant or leased on a long-term basis through the grant are kept at a location other than the university, grantees must be prepared to certify that the vehicle will be used for research purposes only.

Organization of Conferences and Workshops

250. Grant funds must not be used to cover the cost of holding a conference or symposium. Canadian university staff members wishing to obtain funds to support the costs of transportation, meal, and accommodation expenses of guest speakers should apply for a conference grant (see paragraphs 157 to 165). Strategic grant funds may be used for the organization of workshops, provided the request was included in the application. In addition, NSERC is prepared to provide funding for the organization of university-industry workshops (paragraphs 129 to 131) or of other workshops (paragraph 166). Regulations governing these new programs will be stated in the conditions of the award. Council does not have a program of support for attendance at conferences; however, operating grant funds may be used for this purpose (paragraph 248).

— En ce qui touche les congés liés à des activités de recherche à l'extérieur du Canada – les intéressés doivent présenter une demande dans le cadre des programmes internationaux du CRSNG.
— En ce qui touche les conges liés à des activités de recherche au Canada – les bénéficiaires de subventions pour dépenses courantes, de subventions thématiques et du programme conjoint universités-industrie doivent demander au CRSNG la permission d'utiliser leur subvention pour payer leurs frais de déplacement seulement.
— En ce qui touche la prolongation de plus de trois mois d'une visite vers les lieux d'expérience et à une installation à l'étranger, les bénéficiaires doivent en recevoir la permission écrite du CRSNG.

Les frais de déplacement imputables aux subventions du CRSNG doivent être conformes aux procédures et politiques courantes de l'université de chaque bénéficiaire; cette dernière peut refuser les dépenses proposées par le bénéficiaire si elles sont contraire à ses politiques ou aux règlements du CRSNG. Voir l'article 211 pour la présentation des demandes de frais de déplacement.

Les subventions du CRSNG ne doivent pas servir à payer les dépenses de voyage des membres de la famille immédiate du bénéficiaire.

Véhicules motorisés

249. Les bénéficiaires de subventions du CRSNG peuvent acheter un véhicule motorisé lorsque ce dernier est essentiel à la conduite des travaux de recherche subventionnés. Les bénéficiaires doivent cependant obtenir l'approbation de l'université avant d'acheter tout véhicule motorisé. En approuvant l'achat, l'université accepte de fournir les assurances et les permis nécessaires et d'enregistrer le véhicule à son nom. Les bénéficiaires peuvent également utiliser leurs subventions pour payer les frais de location à long terme ou à court terme de tels véhicules lorsqu'ils sont essentiels à la conduite des travaux de recherche subventionnés. Les bénéficiaires qui désirent louer un véhicule motorisé à long terme doivent obtenir l'autorisation préalable de l'université tout comme s'ils désiraient en faire l'achat pur et simple.

Les frais de location à court terme de véhicules seront indiqués sur les demandes de frais de déplacement avec les autres dépenses de voyage vers les lieux d'expérience, etc.

Si les véhicules motorisés achetés ou loués à long terme avec les subventions du CRSNG sont gardés ailleurs qu'à l'université, les bénéficiaires doivent être prêts à certifier que le véhicule servira exclusivement aux fins de la recherche.

Organisation de conférences et colloques

250. Il est interdit de se servir des subventions pour payer les frais d'organisation de conférences. Si un membre du corps enseignant d'une université canadienne désire obtenir des fonds pour payer les frais de déplacement, de repas et de logement de conférenciers invités, il doit demander une subvention pour conférences (voir les articles 157 à 165). On peut se servir des subventions de recherche thématique pour organiser un colloque, à condition d'en avoir fait la demande. De plus, le CRSNG est prêt à subventionner des colloques dans le cadre de son programme conjoint universités-industrie (articles 129 à 131) ou dans d'autres circonstances (article 166). Les règlements s'appliquant à ces nouveaux programmes seront énoncés dans les conditions d'octroi. Le CRSNG n'a pas de programme de subvention pour venir en aide aux chercheurs qui participent à des conférences; les subventions de recherche peuvent cependant être utilisées à cette fin (voir l'article 248).